Basler scout

USER'S MANUAL

(for Scout-f Cameras Used with Basler's BCAM API)

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BASLER
VISION TECHNOLOGIES

For customers in the U.S.A.

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

You are cautioned that any changes or modifications not expressly approved in this manual could void your authority to operate this equipment.

The shielded interface cable recommended in this manual must be used with this equipment in order to comply with the limits for a computing device pursuant to Subpart J of Part 15 of FCC Rules.

For customers in Canada

This apparatus complies with the Class A limits for radio noise emissions set out in Radio Interference Regulations.

Pour utilisateurs au Canada

Cet appareil est conforme aux normes Classe A pour bruits radioélectriques, spécifiées dans le Règlement sur le brouillage radioélectrique.

Life Support Applications

These products are not designed for use in life support appliances, devices, or systems where malfunction of these products can reasonably be expected to result in personal injury. Basler customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify Basler for any damages resulting from such improper use or sale.

Warranty Note

Do not open the housing of the camera. The warranty becomes void if the housing is opened.

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1 Specifications, Requirements, and Precautions

This section lists the camera models covered by the manual. It provides the general specifications for those models and the basic requirements for using them.

This section also includes specific precautions that you should keep in mind when using the cameras. We strongly recommend that you read and follow the precautions.

1.1 Models

The current Basler IEEE 1394 camera models are listed in the top row of the specification tables on the next pages of this manual. The camera models are differentiated by their sensor size, their maximum frame rate at full resolution, and whether the camera's sensor is mono or color.

The scout camera models are available in the following housing variants:

- standard housing
- 90° head housing

The housing variants other than the standard housing are appended to the camera's name, e.g. scA640-70fm/fc 90° head.

Unless otherwise noted, the material in this manual applies to all of the camera models listed in the tables. Material that only applies to a particular camera model or to a subset of models, such as to color cameras or a specific housing variant only, will be so designated.

1.2 General Specifications

Specification	scA640-70fm/fc	scA640-74fm/fc	scA750-60fm/fc
Sensor Size (H x V pixels)	fm: 659 x 494 fc: 658 x 492	fm: 659 x 494 fc: 658 x 492	fm: 752 x 480 fc: 750 x 480
Sensor Type	Sony ICX424 AL/AQ	Sony ICX414 AL/AQ	Micron MT9V022
	Progressive scan CCD		Progressive scan CMOS
Optical Size	1/3"	1/2"	1/3"
Pixel Size	7.4 µm x 7.4 µm	9.9 µm x 9.9 µm	6.0 µm x 6.0 µm
Max. Frame Rate (at full resolution with 8 bit output)	71 fps	74 fps	64.9 fps
Mono/Color	All models available in mono or color		
Data Output Type	IEEE 1394b		
Pixel Data Formats	Mono Models:		
	Mono 8, Mono 12 Packed, Mono 16, YUV 4:2:2, YUV 4:2:2 (YUYV)		Mono 8, YUV 4:2:2, YUV 4:2:2 (YUYV)
	Color Models:		
	Mono 8, Raw 8, Raw 12 Packed, Raw 16, YUV 4:2:2, YUV 4:2:2 (YUYV)		Mono 8, Raw 8, YUV 4:2:2, YUV 4:2:2 (YUYV)
ADC Bit Depth	12 bits		10 bits
Synchronization	Via external trigger signal, via the IEEE 1394 bus, or free run		
Exposure Control	Programmable via the IEEE 1394 bus		
Camera Power Requirements	+8 to +36 VDC supplied via the IEEE 1394 cable, < 1% ripple		
Typical Power Consumption	2.5 W @ 12 V		1.7 W @ 12 VDC
I/O Ports	2 opto-isolated input ports and 4 opto-isolated output ports		
Lens Adapter	C-mount (CS-mount optional)		

Specification	scA640-70fm/fc	scA640-74fm/fc	scA750-60fm/fc
Size (L x W x H) (standard housing)	73.7 mm x 44 mm x 29 mm (without lens adapter or connectors) 85.5 mm x 44 mm x 29 mm (with lens adapter and connectors)		
(90° head housing)	91.65 mm x 44 mm x 29 mm (without connectors and front module) 97 mm x 44 mm x 41.8 mm (with connectors and front module)		
Weight (standard housing)	160 g (typical)		
(90° head housing)	180 g (typical)		
Conformity	CE, FCC, DCAM, IP30		

Table 1: General Specifications

Specification	scA780-54fm/fc	scA1000-20fm/fc	scA1000-30fm/fc
Sensor Size (H x V pixels)	fm: 782 x 582 fc: 780 x 580	fm: 1034 x 779 fc: 1032 x 778	fm: 1034 x 779 fc: 1032 x 778
Sensor Type	Sony ICX415 AL/AQ	Sony ICX204 AL/AK	Sony ICX204 AL/AK
	Progressive scan CCD		
Optical Size	1/2"	1/3"	1/3"
Pixel Size	8.3 µm x 8.3 µm	4.65 µm x 4.65 µm	4.65 µm x 4.65 µm
Max. Frame Rate (at full resolution with 8 bit output)	58 fps	20 fps	30 fps
Mono/Color	All models available in mono or color		
Data Output Type	IEEE 1394b		
Pixel Data Formats	Mono Models:		
	Mono 8, Mono 12 Packed, Mono 16, YUV 4:2:2, YUV 4:2:2 (YUYV)		
	Color Models:		
	Mono 8, Raw 8, Raw 12 Packed, Raw 16, YUV 4:2:2, YUV 4:2:2 (YUYV)		
ADC Bit Depth	12 bits		
Synchronization	Via external trigger signal, via the IEEE 1394 bus, or free run		
Exposure Control	Programmable via the IEEE 1394 bus		
Camera Power Requirements	+8 to +36 VDC supplied via the IEEE 1394 cable, < 1% ripple		
Typical Power Consumption	2.5 W @ 12 V		
I/O Ports	2 opto-isolated input ports 4 opto-isolated output ports		
Lens Adapter	C-mount (CS-mount optional)		

Specification	scA780-54fm/fc	scA1000-20fm/fc	scA1000-30fm/fc
Size (L x W x H) (standard housing)	73.7 mm x 44 mm x 29 mm (without lens adapter or connectors) 85.5 mm x 44 mm x 29 mm (with lens adapter and connectors)		
(90° head housing)	91.65 mm x 44 mm x 29 mm (without connectors and front module) 97 mm x 44 mm x 41.8 mm (with connectors and front module)		
Weight (standard housing)	160 g (typical)		
(90° head housing)	180 g (typical)		
Conformity	CE, FCC, DCAM, IP30		

Table 2: General Specifications

Specification	scA1300-32fm/fc*	scA1390-17fm/fc	scA1400-17fm/fc
Sensor Size (H x V pixels)	fm: 1296 x 966 fc: 1294 x 964	fm: 1392 x 1040 fc: 1390 x 1038	fm: 1392 x 1040 fc: 1390 x 1038
Sensor Type	Sony ICX445 ALA/AQA	Sony ICX267 AL/AK	Sony ICX285 AL/AQ
	Progressive scan CCD		
Optical Size	1/3"	1/2"	2/3"
Pixel Size	3.75 µm x 3.75 µm	4.65 µm x 4.65 µm	6.45 µm x 6.45 µm
Max. Frame Rate (at full resolution with 8 bit output)	33 fps	17 fps	17 fps
Mono/Color	All models available in mono or color		
Data Output Type	IEEE 1394b		
Pixel Data Formats	Mono Models:		
	Mono 8, Mono 12 Packed, Mono 16, YUV 4:2:2, YUV 4:2:2 (YUYV)		
	Color Models:		
	Mono 8, Raw 8, Raw 12 Packed, Raw 16, YUV 4:2:2, YUV 4:2:2 (YUYV)		
ADC Bit Depth	12 bits		
Synchronization	Via external trigger signal, via the IEEE 1394 bus, or free run		
Exposure Control	Programmable via the IEEE 1394 bus		
Camera Power Requirements	+8 to +36 VDC supplied via the IEEE 1394 cable, < 1% ripple		
Typical Power Consumption	3.0 W @ 12 V	2.75 W @ 12 V	3.0 W @ 12 V
I/O Ports	2 opto-isolated input ports 4 opto-isolated output ports		
Lens Adapter	C-mount (CS-mount optional)		

* The information for the scA1300-32fm/fc cameras is preliminary.

Specification	scA1300-32fm/fc	scA1390-17fm/fc	scA1400-17fm/fc
Size (L x W x H) (standard housing)	73.7 mm x 44 mm x 29 mm (without lens adapter or connectors) 85.5 mm x 44 mm x 29 mm (with lens adapter and connectors)		
(90° head housing)	Not applicable	91.65 mm x 44 mm x 29 mm (without connectors and front module) 97 mm x 44 mm x 41.8 mm (with connectors and front module)	
Weight (standard housing)	160 g (typical)	160 g (typical)	170 g (typical)
(90° head housing)	Not applicable	180 g (typical)	190 g (typical)
Conformity	CE, FCC, DCAM, IP30		

Table 3: General Specifications

* The information for the scA1300-32fm/fc cameras is preliminary.

Specification	scA1400-30fm/fc	scA1600-14fm/fc
Sensor Size (H x V pixels)	fm: 1392 x 1040 fc: 1390 x 1038	fm: 1626 x 1236 fc: 1624 x 1234
Sensor Type	Sony ICX285 AL/AQ	Sony ICX274 AL/AQ
	Progressive scan CCD	
Optical Size	2/3"	1/1.8"
Pixel Size	6.45 µm x 6.45 µm	4.4 µm x 4.4 µm
Max. Frame Rate (at full resolution with 8 bit output)	30 fps	13 fps
Mono/Color	All models available in mono or color	
Data Output Type	IEEE 1394b	
Pixel Data Formats	Mono Models:	
	Mono 8, Mono 12 Packed, Mono 16, YUV 4:2:2, YUV 4:2:2 (YUYV)	
	Color Models:	
	Mono 8, Raw 8, Raw 12 Packed, Raw 16, YUV 4:2:2, YUV 4:2:2 (YUYV)	
ADC Bit Depth	12 bits	
Synchronization	Via external trigger signal, via the IEEE 1394 bus, or free run	
Exposure Control	Programmable via the IEEE 1394 bus	
Camera Power Requirements	+8 to +36 VDC supplied via the IEEE 1394 cable, < 1% ripple	
Typical Power Consumption	3.7 W @ 12 V	2.75 W @ 12 V
I/O Ports	2 opto-isolated input ports 4 opto-isolated output ports	
Lens Adapter	C-mount (CS-mount optional)	

Specification	scA1400-30fm/fc	scA1600-14fm/fc
Size (L x W x H) (standard housing)	73.7 mm x 44 mm x 29 mm (without lens adapter or connectors) 85.5 mm x 44 mm x 29 mm (with lens adapter and connectors)	
(90° head housing)	91.65 mm x 44 mm x 29 mm (without connectors and front module) 97 mm x 44 mm x 41.8 mm (with connectors and front module)	
Weight (standard housing)	170 g (typical)	160 g (typical)
(90° head housing)	190 g (typical)	180 g (typical)
Conformity	CE, FCC, DCAM, IP30	

Table 4: General Specifications

1.3 Spectral Response for Mono Cameras

The following graphs show the spectral response for each available monochrome camera model.

Note

The spectral response curves excludes lens characteristics and light source characteristics.

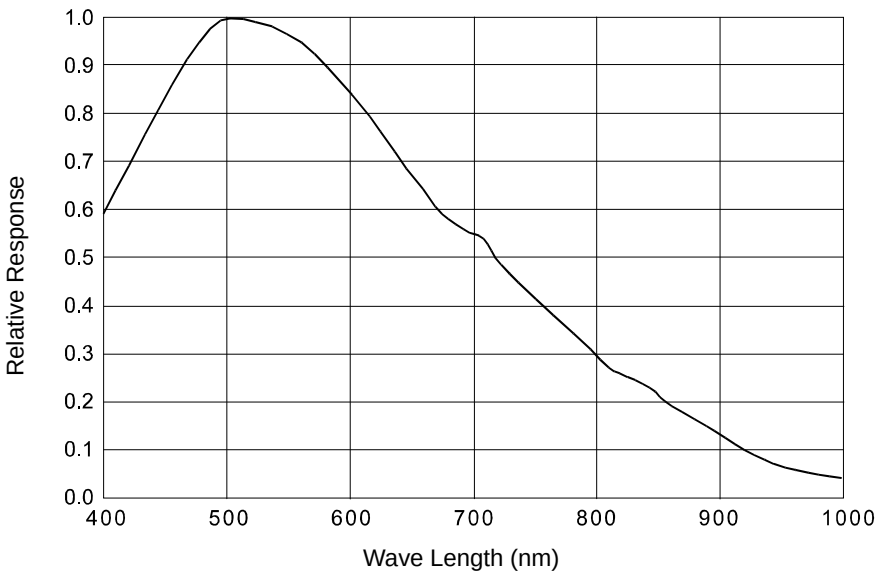


Fig. 1: scA640-70fm Spectral Response

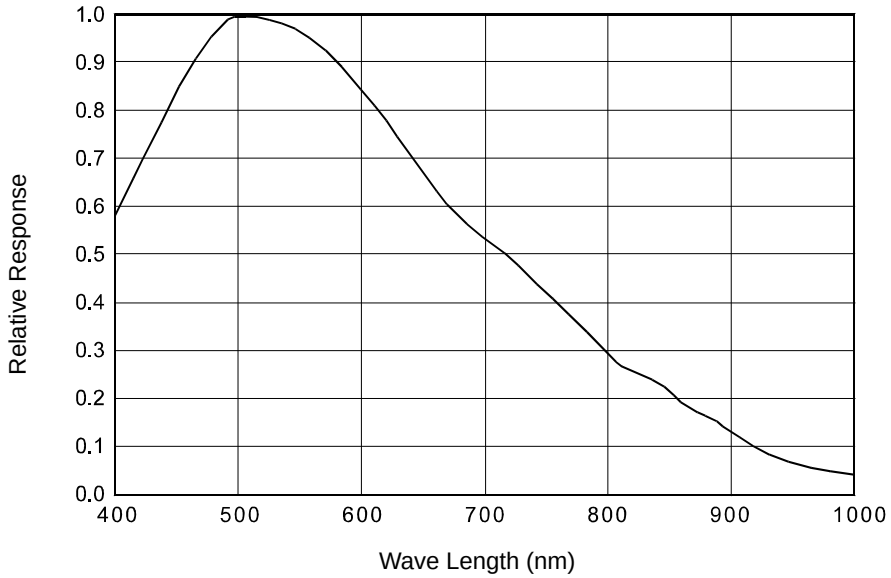


Fig. 2: scA640-74fm Spectral Response

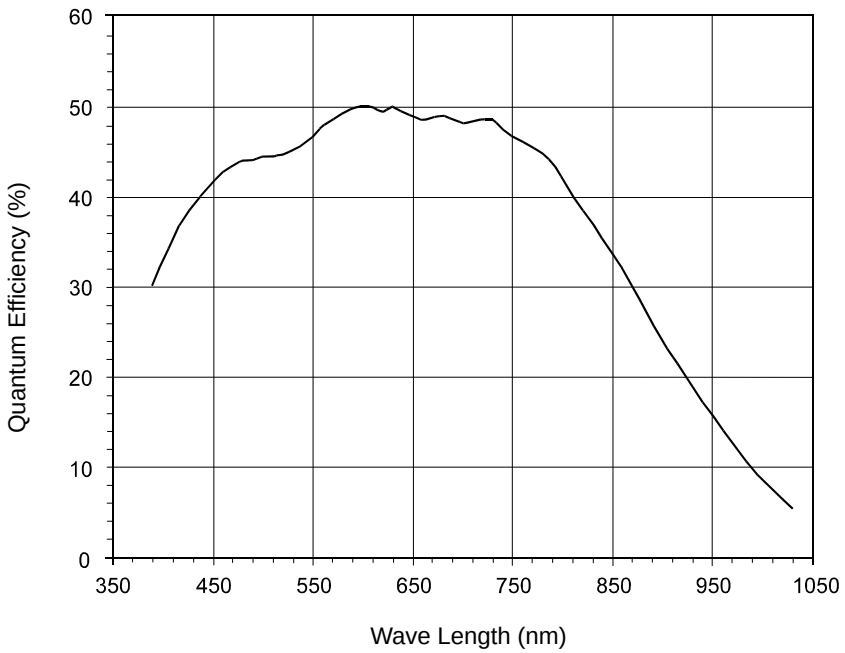


Fig. 3: scA750-60fm Spectral Response

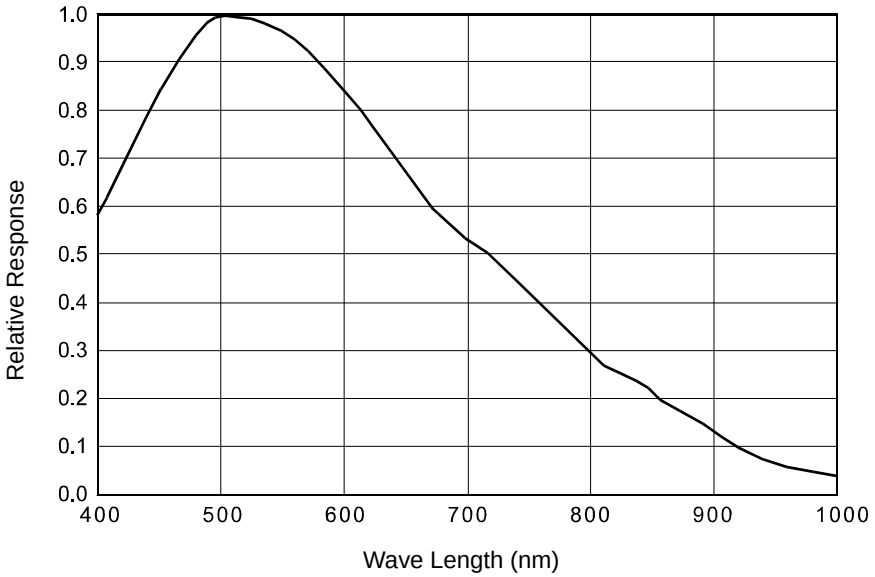


Fig. 4: scA780-54fm Spectral Response

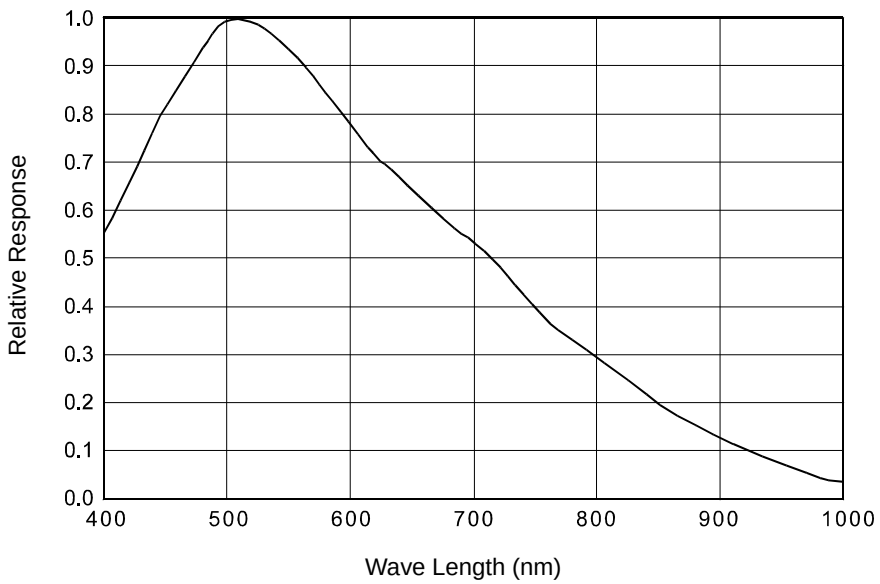


Fig. 5: scA1000-20fm and scA1000-30fm Spectral Response

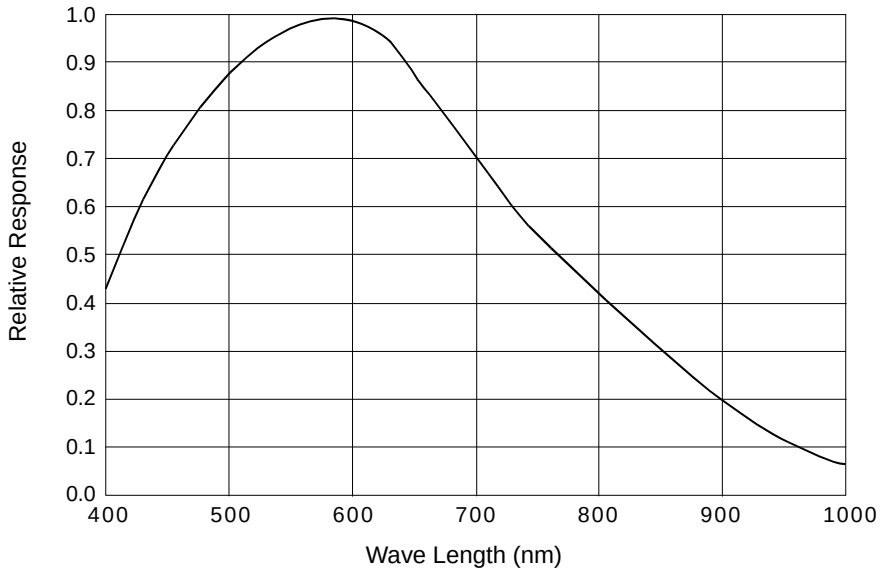


Fig. 6: scA1300-32fm Spectral Response

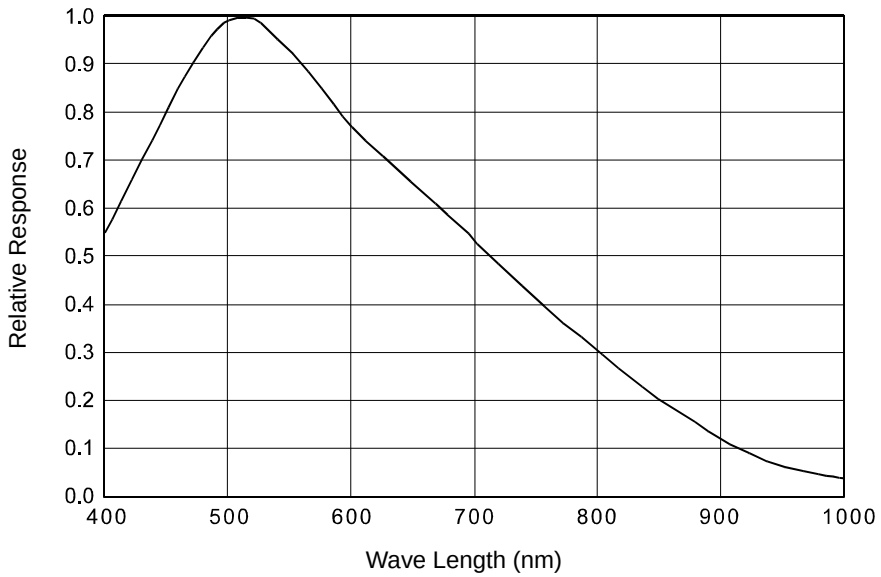


Fig. 7: scA1390-17fm Spectral Response

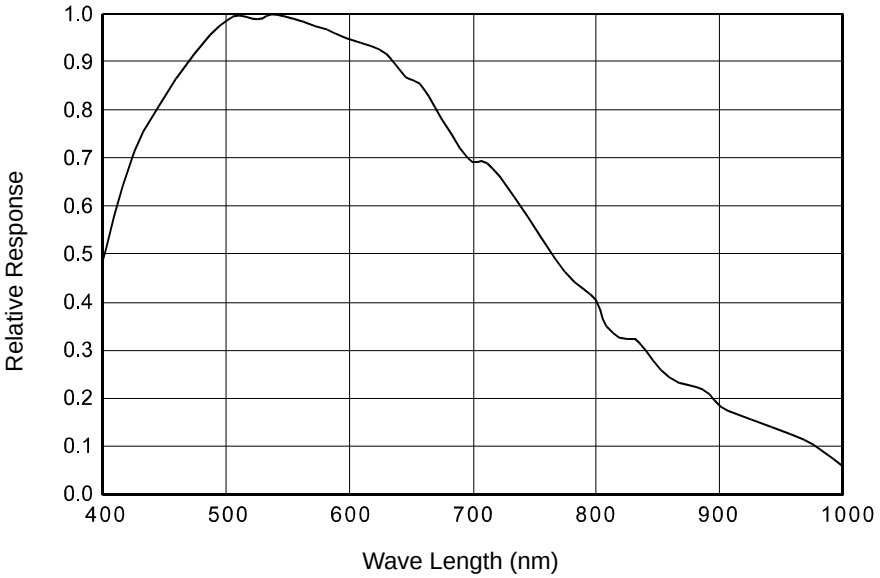


Fig. 8: scA1400-17fm and scA1400-30fm Spectral Response

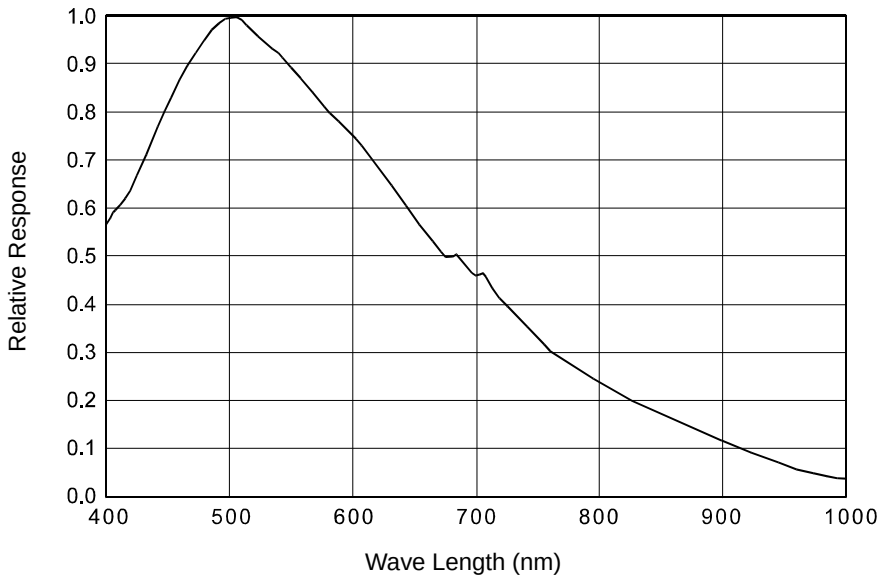


Fig. 9: scA1600-14fm Spectral Response

1.4 Spectral Response for Color Cameras

The following graphs show the spectral response for each available color camera model.

Note

The spectral response curves exclude lens characteristics, light source characteristics, and IR cut filter characteristics.

To obtain best performance from color models of the camera, use of a dielectric IR cut filter is recommended. The filter should transmit in a range from 400 nm to 700 ... 720 nm, and it should cut off from 700 ... 720 nm to 1100 nm.

A suitable IR cut filter is included in the standard C-mount lens adapter on color models of the camera. (An IR cut filter is not included in the optional CS-mount adapter.)

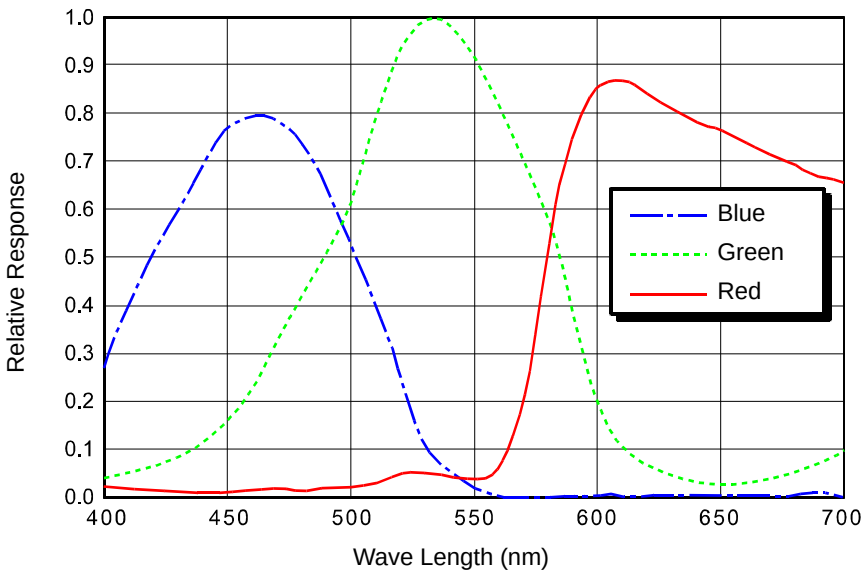


Fig. 10: scA640-70fc Spectral Response

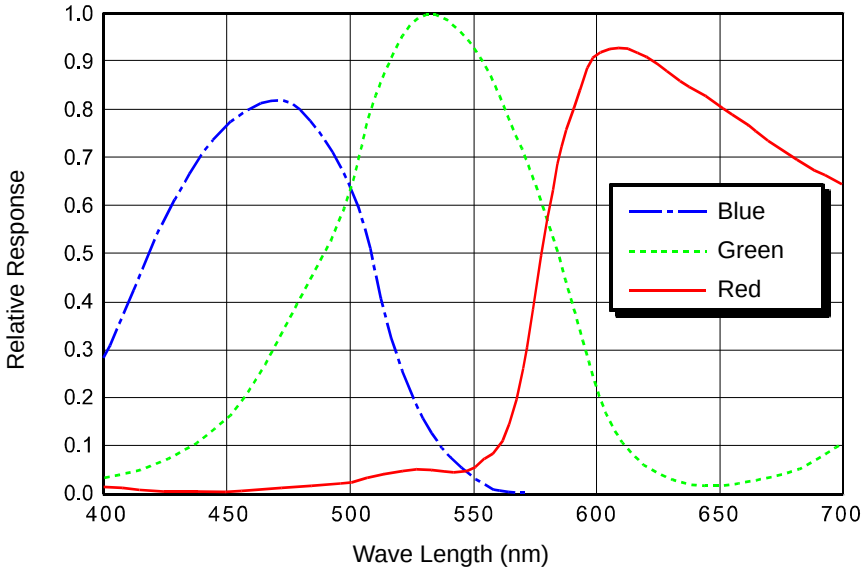


Fig. 11: scA640-74fc Spectral Response

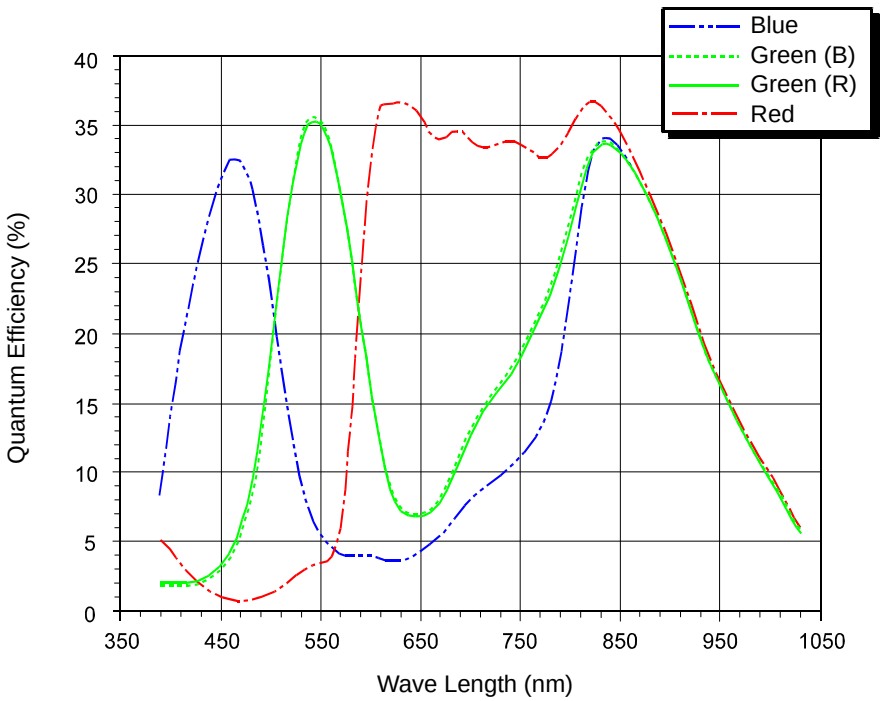


Fig. 12: scA750-60fc Spectral Response

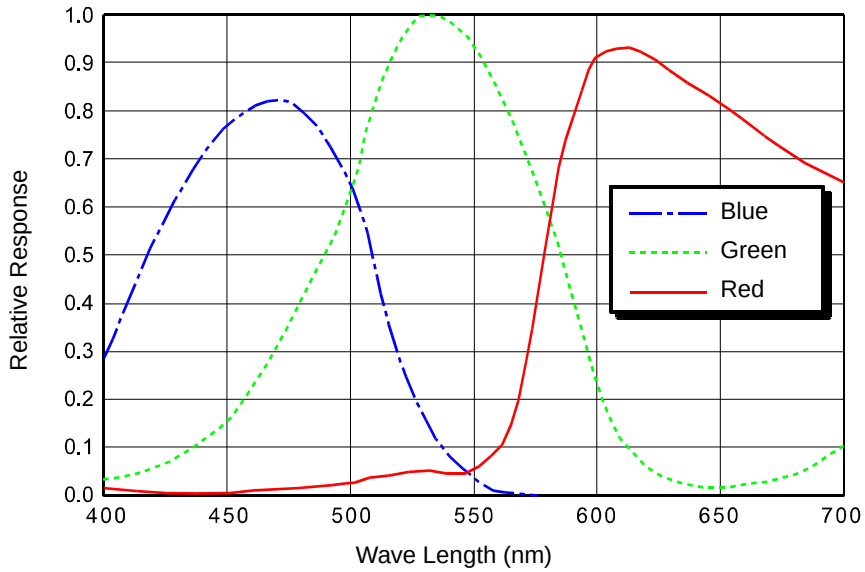


Fig. 13: scA780-54fc Spectral Response

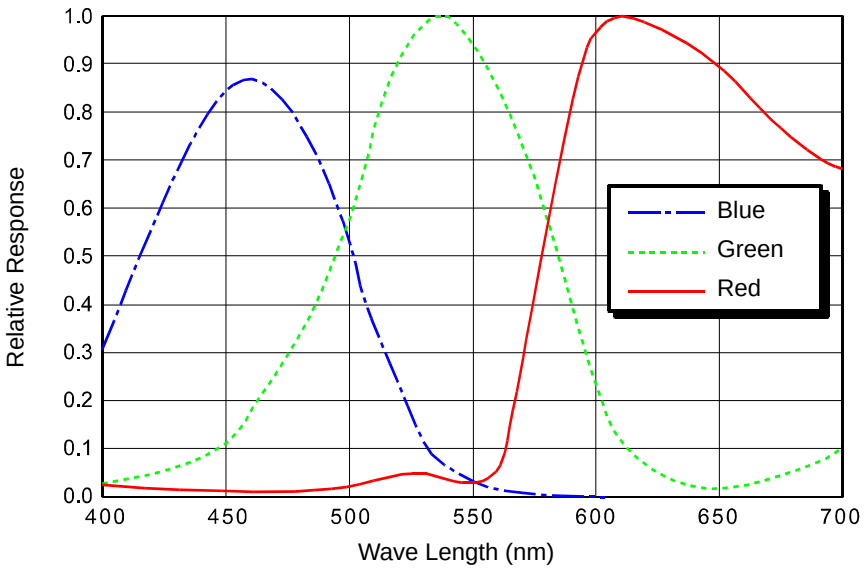


Fig. 14: scA1000-20fc and scA1000-30fc Spectral Response

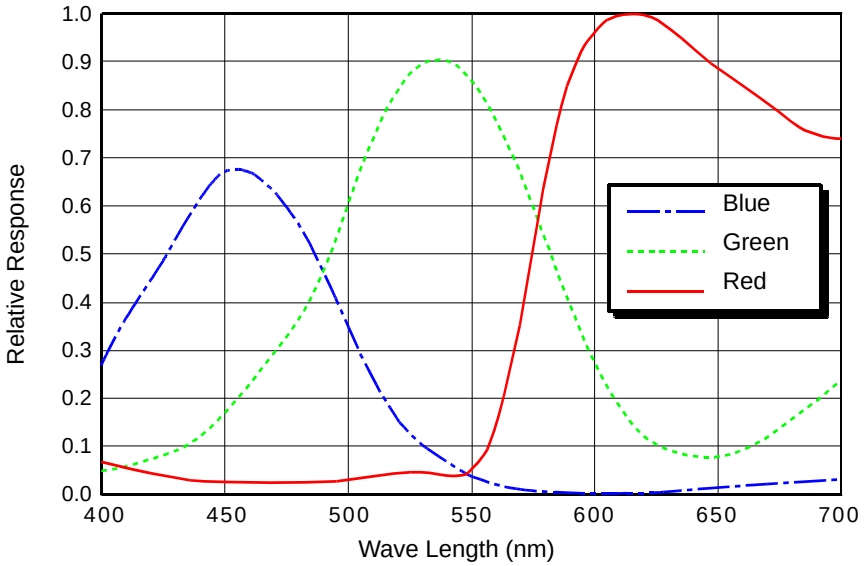


Fig. 15: scA1300-32fc Spectral Response

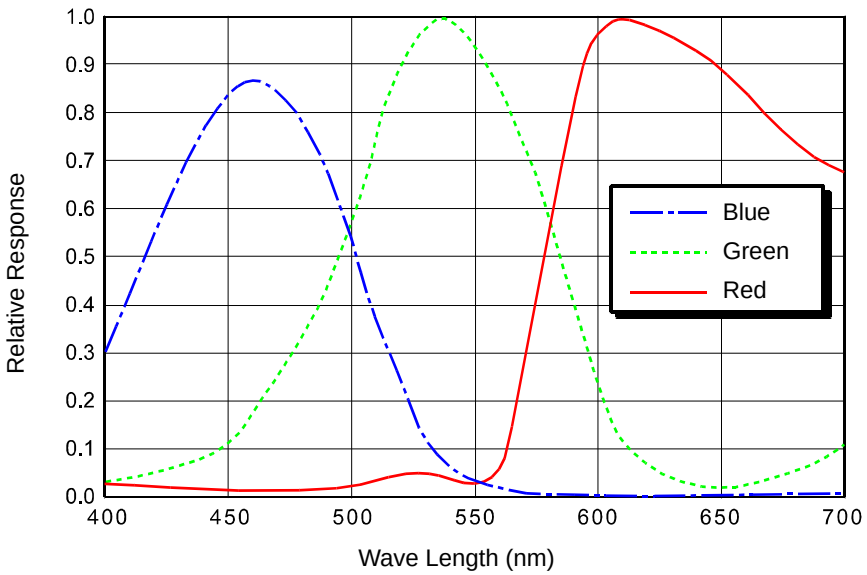


Fig. 16: scA1390-17fc Spectral Response

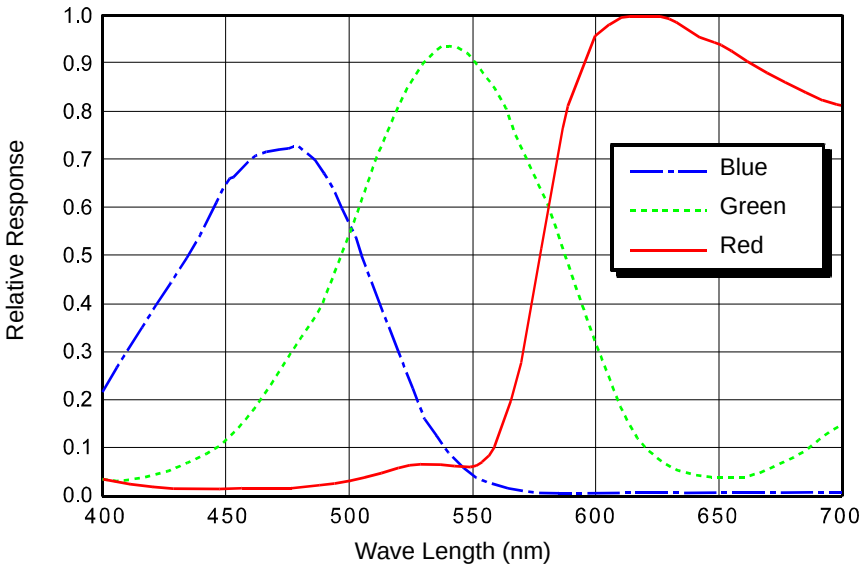


Fig. 17: scA1400-17fc and scA1400-30fc Spectral Response

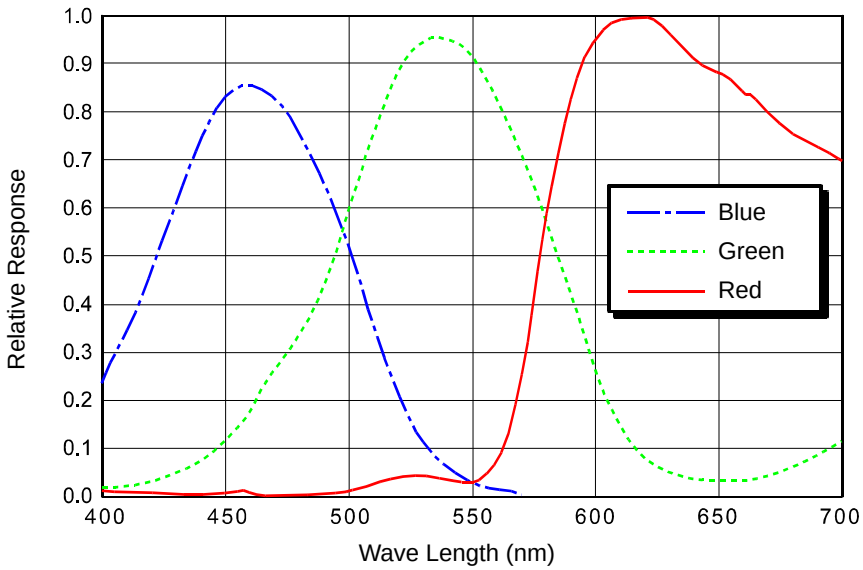


Fig. 18: scA1600-14fc Spectral Response

1.5 Mechanical Specifications

1.5.1 Standard Housing

The camera housing conforms to protection class IP30 provided the lens mount is covered by a lens or by the cap that is shipped with the camera.

1.5.1.1 Camera Dimensions and Mounting Points

The cameras are manufactured with high precision. Planar, parallel, and angular sides guarantee precise mounting with high repeatability.

The dimensions in millimeters for cameras equipped with a standard C-mount lens adapter are as shown in Figure 19. The dimensions for cameras equipped with an optional CS-mount lens adapter are shown in Figure 20 on page 22.

Camera housings are equipped with four mounting holes on the top and four mounting holes on the bottom as shown in the drawings.

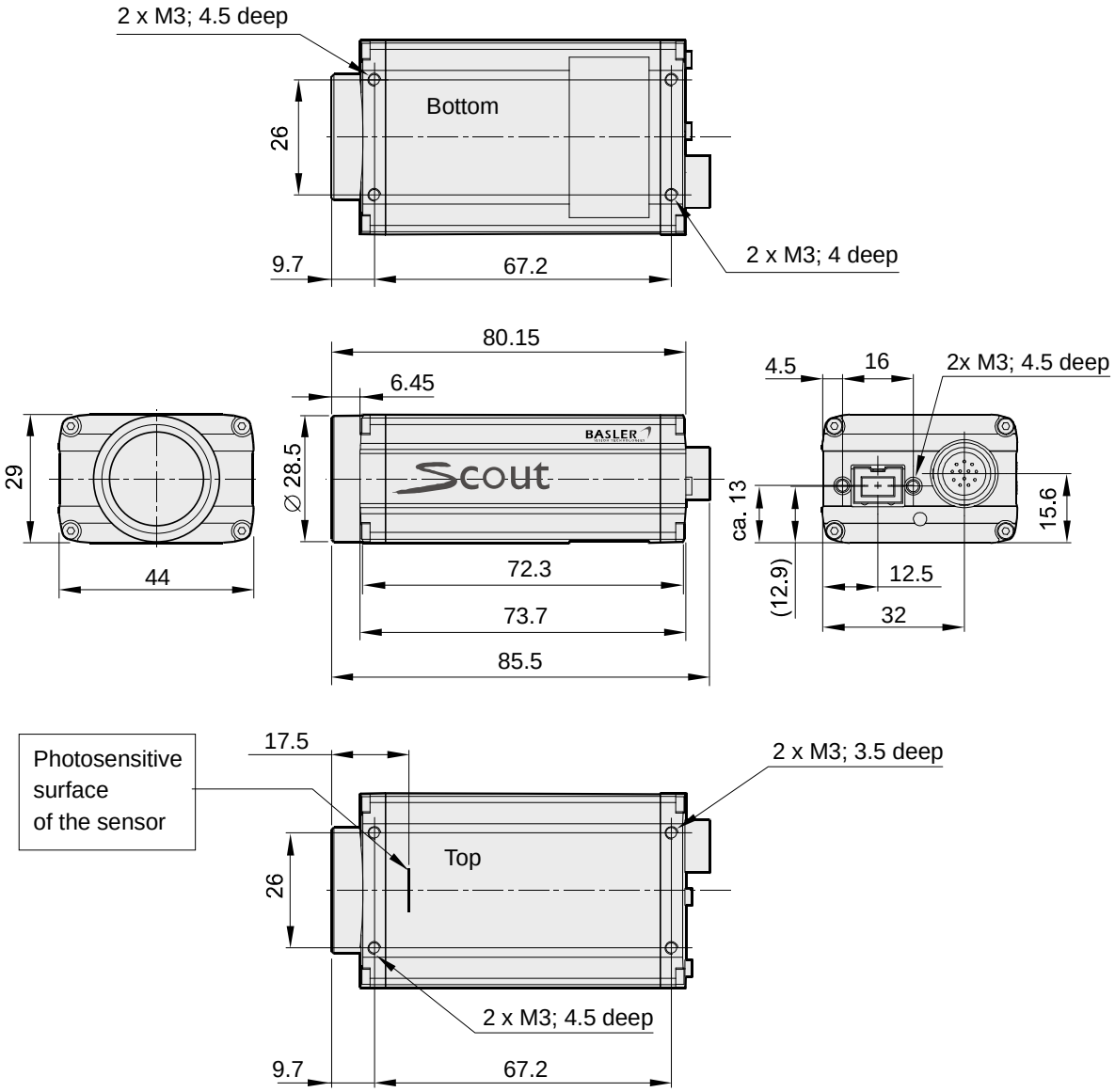


Fig. 19: Mechanical Dimensions (in mm) for Cameras with the Standard C-mount Lens Adapter

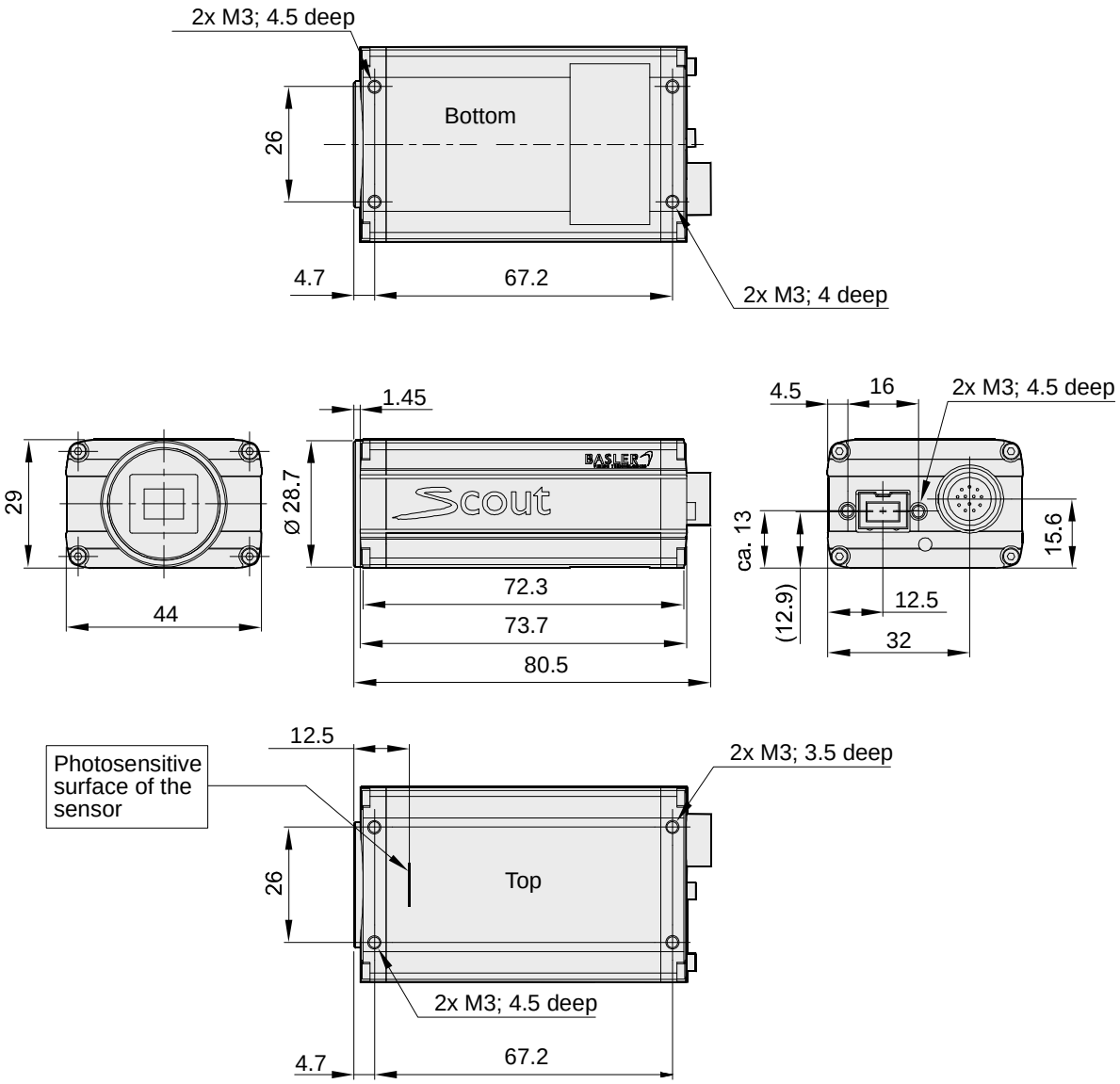
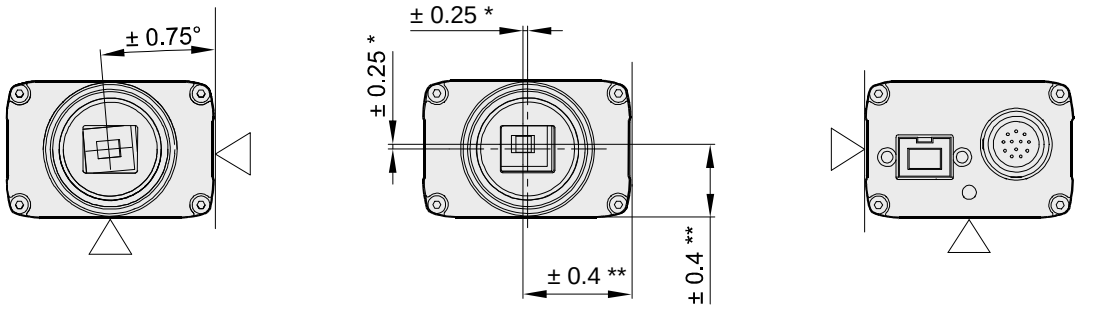


Fig. 20: Mechanical Dimensions (in mm) for Cameras with an Option CS-mount Lens Adapter

1.5.1.2 Sensor Positioning Accuracy

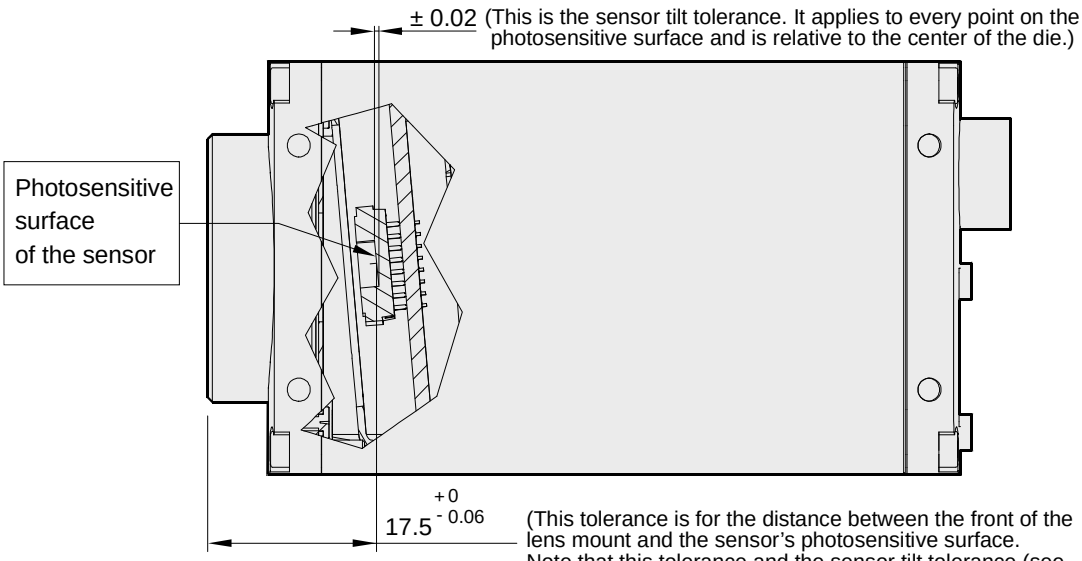
The sensor positioning accuracy for cameras equipped with a standard C-mount lens adapter is as shown in Figure 21. The sensor positioning accuracy for cameras equipped with an optional CS-mount lens adapter is as shown in Figure 22 on page 24.



▷ = reference plane

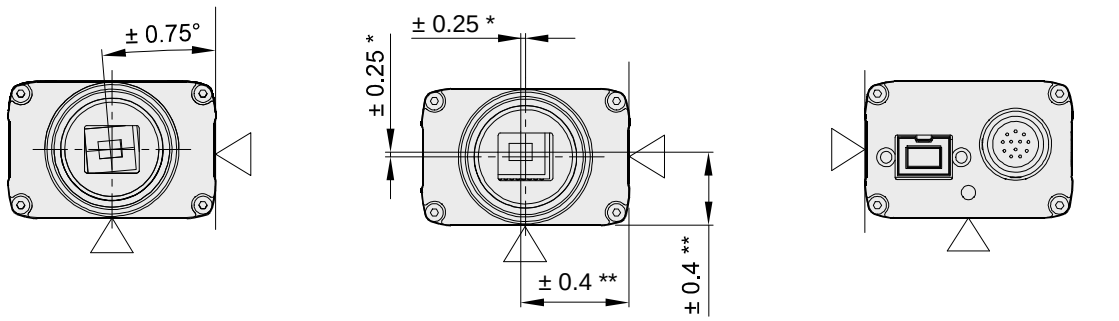
* = tolerance to the center of the lens mount (optical axis)

** = tolerance to the reference planes


± 0.02 (This is the sensor tilt tolerance. It applies to every point on the photosensitive surface and is relative to the center of the die.)
Photosensitive surface of the sensor
17.5 +0 -0.06
(This tolerance is for the distance between the front of the lens mount and the sensor's photosensitive surface. Note that this tolerance and the sensor tilt tolerance (see above) must be combined to obtain the total tolerance for every point on the photosensitive surface.)

Maximum Sensor Tilt Angle (Degrees)					
Camera	**Tilt X**	**Tilt Y**	**Camera**	**Tilt X**	**Tilt Y**
scA640-70fm/fc	0.47	0.63	**scA1300-32fm/fc**	0.47	0.63
scA640-74fm/fc	0.35	0.47	**scA1390-17fm/fc**	0.31	0.42
scA750-60fm/fc	0.51	0.80	**scA1400-17fm/fc**	0.25	0.34
scA780-54fm/fc	0.35	0.47	**scA1400-30fm/fc**	0.25	0.34
scA1000-20fm/fc	0.46	0.63	**scA1600-14fm/fc**	0.34	0.52
scA1000-30fm/fc	0.46	0.63			

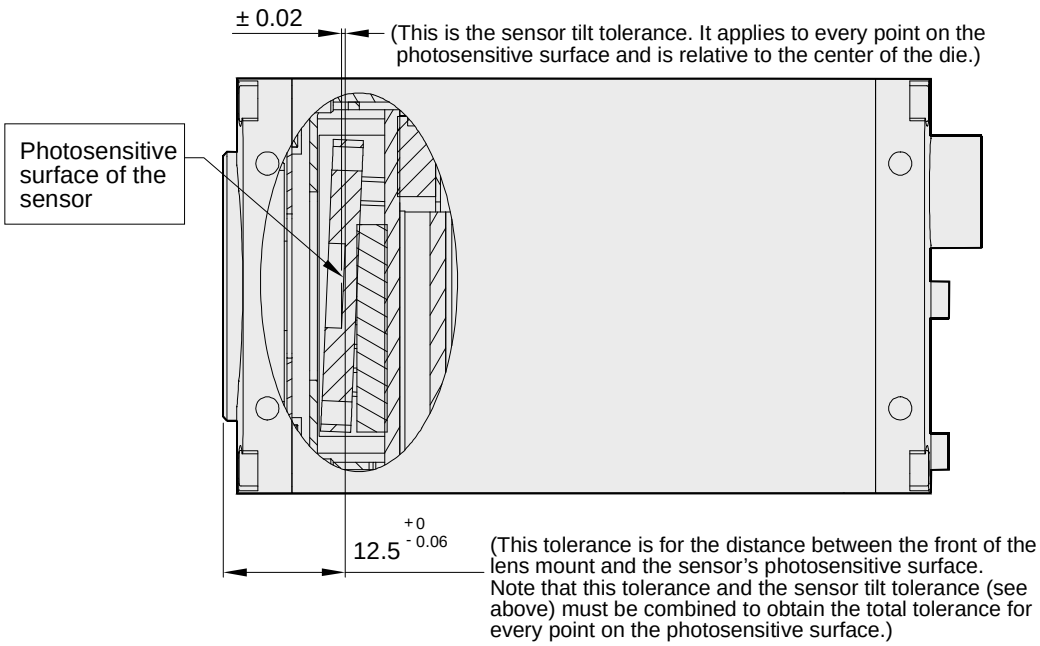
Fig. 21: Sensor Positioning Accuracy for Cameras with the Standard C-mount Lens Adapter (in mm unless otherwise noted)



▷ = reference plane

* = tolerance to the center of the lens mount (optical axis)

** = tolerance to the reference planes


± 0.02
(This is the sensor tilt tolerance. It applies to every point on the photosensitive surface and is relative to the center of the die.)
Photosensitive surface of the sensor
12.5 +0 -0.06
(This tolerance is for the distance between the front of the lens mount and the sensor's photosensitive surface. Note that this tolerance and the sensor tilt tolerance (see above) must be combined to obtain the total tolerance for every point on the photosensitive surface.)

Maximum Sensor Tilt Angle (Degrees)					
Camera	**Tilt X**	**Tilt Y**	**Camera**	**Tilt X**	**Tilt Y**
scA640-70fm/fc	0.47	0.63	**scA1300-32m/fc**	0.47	0.63
scA640-74fm/fc	0.35	0.47	**scA1390-17fm/fc**	0.31	0.42
scA750-60fm/fc	0.51	0.80	**scA1400-17fm/fc**	0.25	0.34
scA780-54fm/fc	0.35	0.47	**scA1400-30fm/fc**	0.25	0.34
scA1000-20fm/fc	0.46	0.63	**scA1600-14fm/fc**	0.34	0.52
scA1000-30fm/fc	0.46	0.63			

Fig. 22: Sensor Positioning Accuracy for Cameras with an Optional CS-mount Lens Adapter (in mm unless otherwise noted)

1.5.2 90° Head Housing

The camera housing conforms to protection class IP30 provided the lens mount is covered by a lens or by the cap that is shipped with the camera.

1.5.2.1 Camera Dimensions and Mounting Points

In scout cameras with the 90° head housing the camera’s direction of view is at right angle to the direction of view of standard scout cameras.

The cameras are manufactured with high precision. Planar, parallel, and angular sides guarantee precise mounting with high repeatability.

The dimensions in millimeters for cameras equipped with a standard C-mount lens adapter are as shown in Figure 23.

Camera housings are equipped with four mounting holes on the top and four mounting holes on the bottom as shown in the drawings. In addition, there are four mounting holes in the front module (4x M3; 4.5 mm deep).

Note

For optimum accuracy in the positioning of the camera's optical axis, we recommend using the front module reference plane (see the figure in the Sensor Positioning Accuracy section) as mounting surface.

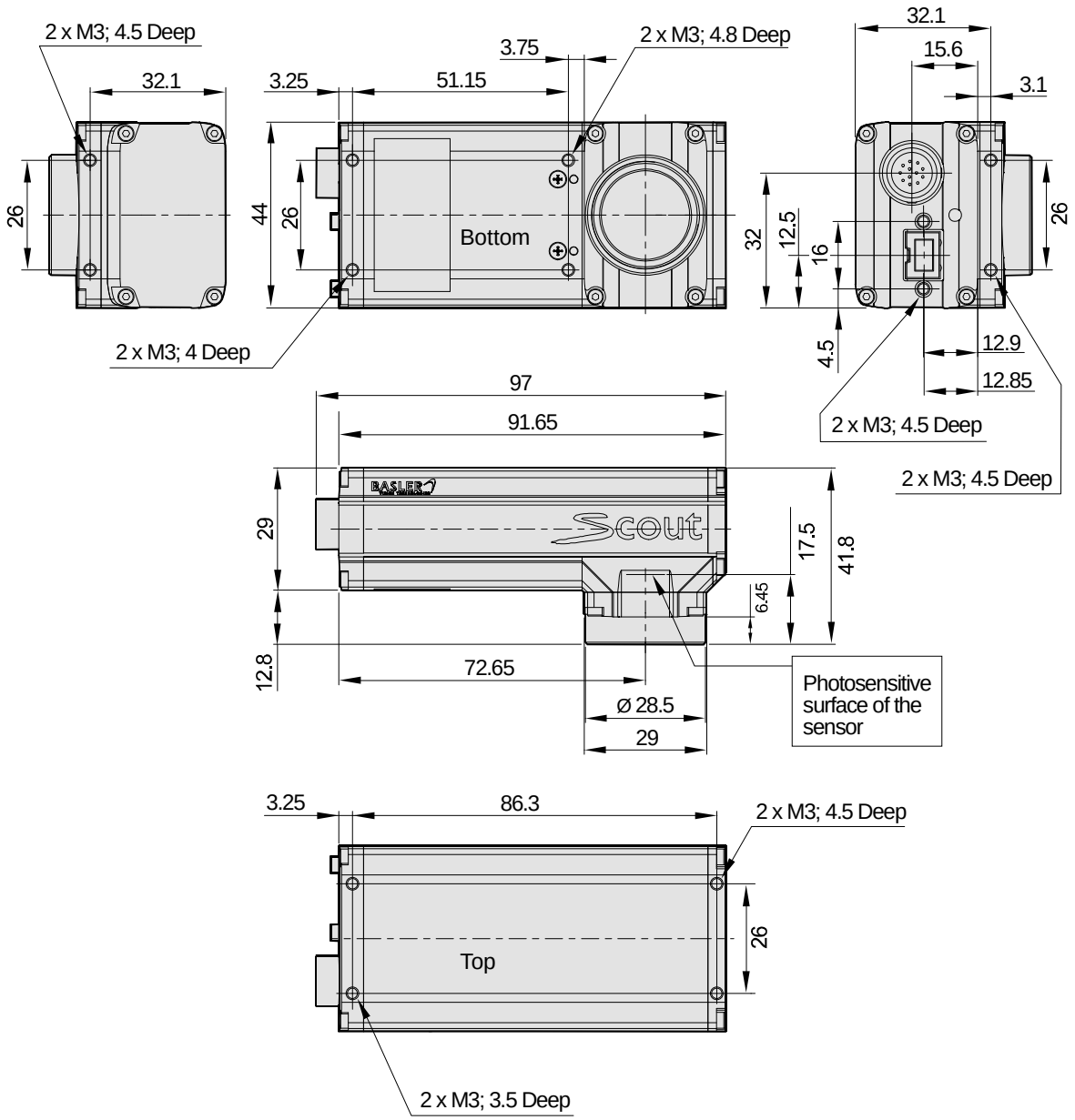
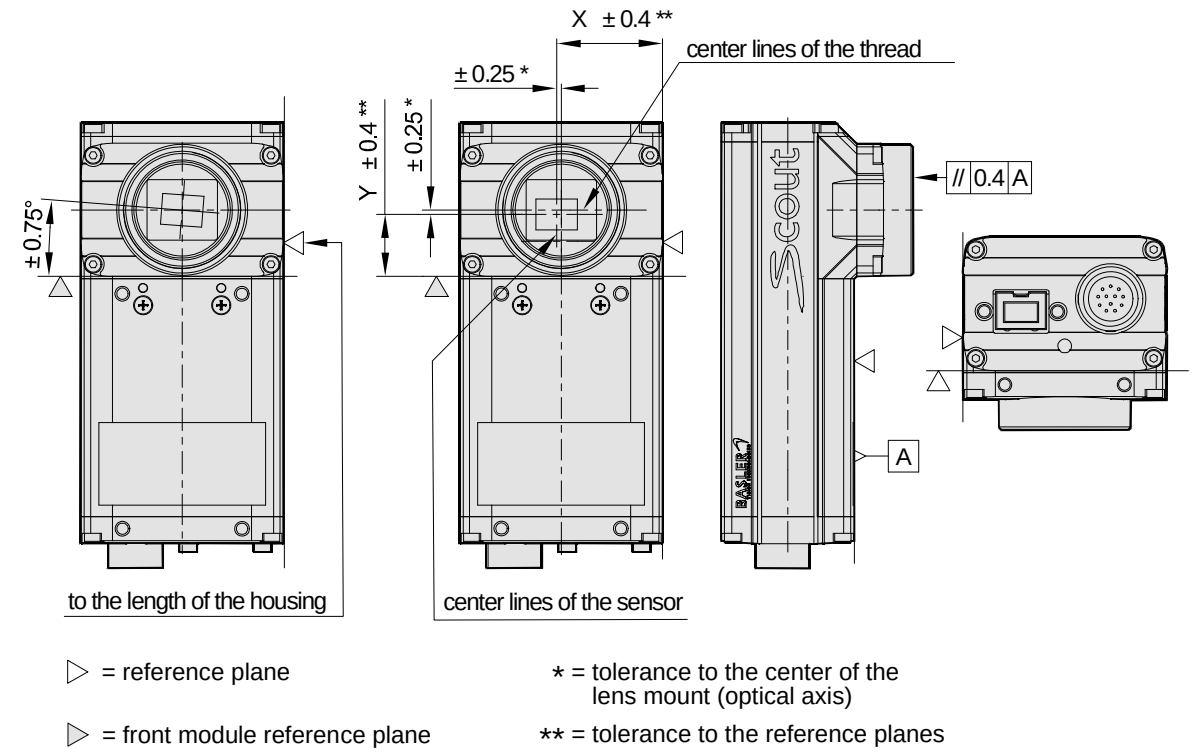
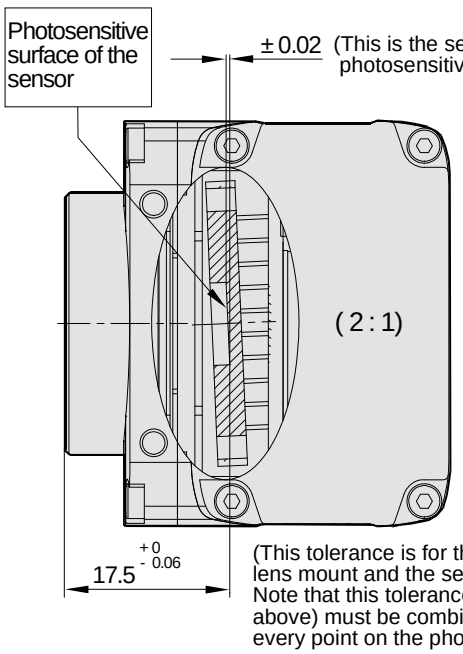


Fig. 23: Mechanical Dimensions (in mm) for Cameras (90° Head) with the Standard C-mount Lens Adapter

1.5.2.2 Sensor Positioning Accuracy

The sensor positioning accuracy for cameras equipped with a standard C-mount lens adapter is as shown in Figure 24.


X ±0.4 **
center lines of the thread
±0.25 *
Y ±0.4 **
±0.25 *
±0.75°
// 0.4 A
A
to the length of the housing
center lines of the sensor
▷ = reference plane
* = tolerance to the center of the lens mount (optical axis)
▷ = front module reference plane
** = tolerance to the reference planes


Photosensitive surface of the sensor
±0.02 (This is the sensor tilt tolerance. It applies to every point on the photosensitive surface and is relative to the center of the die)
(2 : 1)
17.5 +0 -0.06
(This tolerance is for the distance between the front of the lens mount and the sensor's photosensitive surface. Note that this tolerance and the sensor tilt tolerance (see above) must be combined to obtain the total tolerance for every point on the photosensitive surface.)

Maximum Sensor Tilt Angle (Degrees)					
Camera	**Tilt X**	**Tilt Y**	**Camera**	**Tilt X**	**Tilt Y**
scA640-70fm/fc	0.47	0.63	**scA1000-30fm/fc**	0.46	0.63
scA640-74fm/fc	0.35	0.47	**scA1390-17fm/fc**	0.31	0.42
scA750-60fm/fc	0.51	0.80	**scA1400-17fm/fc**	0.25	0.34
scA780-54fm/fc	0.35	0.47	**scA1400-30fm/fc**	0.25	0.34
scA1000-20fm/fc	0.46	0.63	**scA1600-14fm/fc**	0.34	0.52

Fig. 24: Sensor Positioning Accuracy for Cameras (90° Head) with the Standard C-mount Lens Adapter (in mm unless otherwise noted)

1.5.3 Maximum Thread Length on Color Cameras

The C-mount lens adapter on color models of the camera is normally equipped with an internal IR cut filter. As shown below, the length of the threads on any lens you use with a color camera must be less than 8.0 mm. If a lens with a longer thread length is used, the IR cut filter will be damaged or destroyed and the camera will no longer operate.

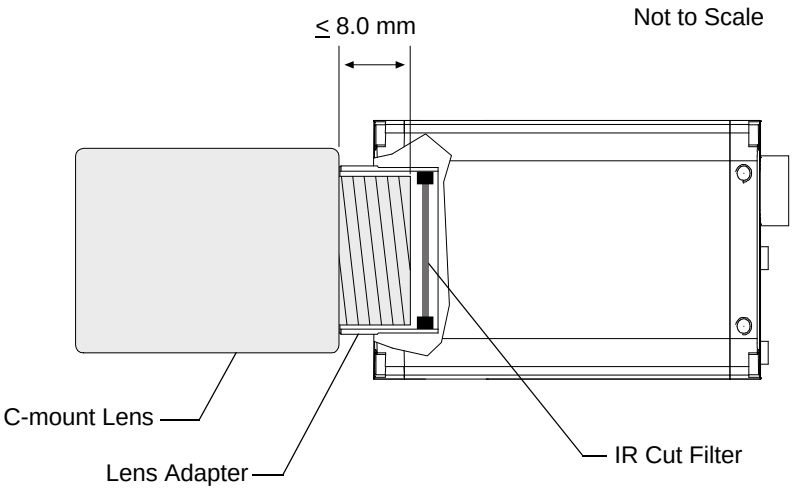


Fig. 25: Maximum Lens Thread Length on Color Cameras

Note

An internal IR cut filter is not included on color cameras equipped with the optional CS-mount adapter.

C-mount color cameras that do not include an internal IR cut filter are available on request.

Monochrome cameras are not normally equipped with an internal IR cut filter, however, they can be equipped with an internal filter on request.

1.5.4 Mechanical Stress Test Results

Scout cameras were submitted to an independent mechanical testing laboratory and subjected to the stress tests listed below. The mechanical stress tests were performed on selected camera models with standard housing. After mechanical testing, the cameras exhibited no detectable physical damage and produced normal images during standard operational testing.

Test	Standard	Conditions
Vibration (sinusoidal, each axis)	DIN EN 60068-2-6	10-58 Hz / 1.5 mm_58-500 Hz / 20 g_1 Octave/Minute 10 repetitions
Shock (each axis)	DIN EN 60068-2-27	20 g / 11 ms / 10 shocks positive 20 g / 11 ms / 10 shocks negative
Bump (each axis)	DIN EN 60068-2-29	20 g / 11 ms / 100 shocks positive 20 g / 11 ms / 100 shocks negative
Vibration (broad-band random, digital control, each axis)	DIN EN 60068-2-64	15-500 Hz / 0.05 PSD (ESS standard profile) / 00:30 h

Table 5: Mechanical Stress Tests

The mechanical stress tests were performed with a dummy lens connected to a C-mount. The dummy lens was 35 mm long and had a mass of 66 g. Using a heavier or longer lens requires an additional support for the lens.

1.6 Environmental Requirements

1.6.1 Temperature and Humidity

Housing temperature during operation:	0 °C ... +50 °C (+32 °F ... +122 °F)
Humidity during operation:	20 % ... 80 %, relative, non-condensing
Storage temperature:	-20 °C ... +80 °C (-4 °F ... +176 °F)
Storage humidity:	20 % ... 80 %, relative, non-condensing

1.6.2 Ventilation

Allow sufficient air circulation around the camera to prevent internal heat build-up in your system and to keep the camera's housing temperature below 50 °C. Additional cooling devices such as fans or heat sinks are not normally required, but should be provided if necessary.

1.7 Precautions

CAUTION

Avoid Dust on the Sensor

The camera is shipped with a cap on the lens mount. To avoid collecting dust on the camera's IR cut filter (color cameras) or sensor (mono cameras), make sure that you always put the cap in place when there is no lens mounted on the camera.

To further enhance dust protection, the internal space in the camera that contains the imaging sensor is sealed off from the camera's other internal spaces.

CAUTION

Lens Thread Length is Limited

Color models of the camera with a C-mount lens adapter are equipped with an IR cut filter mounted inside of the adapter. The location of this filter limits the length of the threads on any lens you use with the camera. If a lens with a very long thread length is used, the IR cut filter will be damaged or destroyed and the camera will no longer operate.

For more specific information about the lens thread length, see Section 1.5.3 on page 28.

CAUTION

Incorrect Power Can Cause Damage

The polarity of the power on the camera's IEEE 1394b socket must be as shown in the pin assignment table. **Do not** reverse the power polarity. Reversing the polarity will damage the camera.

If the voltage to the camera is greater than +36 VDC, damage to the camera can result. If the voltage is less than +8 VDC, the camera may operate erratically.

Warranty Precautions

To ensure that your warranty remains in force:

Do not remove the camera's serial number label

If the label is removed and the serial number can't be read from the camera's registers, the warranty is void.

Do not open the camera housing

Do not open the housing. Touching internal components may damage them.

Keep foreign matter outside of the camera

Be careful not to allow liquid, flammable, or metallic material inside of the camera housing. If operated with any foreign matter inside, the camera may fail or cause a fire.

Avoid Electromagnetic fields

Do not operate the camera in the vicinity of strong electromagnetic fields. Avoid electrostatic charging.

Transport Properly

Transport the camera in its original packaging only. Do not discard the packaging.

Clean Properly

Avoid cleaning the surface of the camera's sensor if possible. If you must clean it, use a soft, lint free cloth dampened with a small quantity of high quality window cleaner. Because electrostatic discharge can damage the sensor, you must use a cloth that will not generate static during cleaning (cotton is a good choice).

To clean the surface of the camera housing, use a soft, dry cloth. To remove severe stains, use a soft cloth dampened with a small quantity of neutral detergent, then wipe dry.

Do not use solvents or thinners to clean the housing; they can damage the surface finish.

Read the manual

Read the manual carefully before using the camera!

2 Hardware and Software Installation

This section provides the necessary installation procedures to operate the camera. The installation relates to both hardware and software.

The Basler scout IEEE 1394b is not only compliant with IEEE 1394b but is also backward compatible with IEEE 1394a devices. If you use the camera in connection with an IEEE 1394a device, special preparations are necessary as indicated below.

2.1 Preparations

Make sure the following items are available before starting installation:

- A Basler scout IEEE 1394b camera
- A C-mount lens

  If you already know what lens to use, use this lens. Otherwise, we suggest that you use a zoom lens for initial setup. Contact Basler Technical Support if you need assistance in determining the best lens for your application. The contact numbers appear in the title pages of this manual.
- A desktop or laptop computer with an IEEE 1394 connector

  If you use a desktop computer with an IEEE 1394b adapter, make sure the adapter is configured to supply between +8 and +36 VDC to the camera. Also make sure the adapter can supply at least the required power to the camera (see the Input Power Consumption table in the Physical Interface section of this manual). For example, 2.5 W are typically required for the scA640-70fm/fc at 12 VDC.

  If you use a laptop, make sure the laptop is configured to supply sufficient power to the camera. Many laptops have IEEE 1394 connectors. Note that on almost all laptops, it is an IEEE 1394a connector. Most laptops **do not** supply power via the IEEE 1394 connector. In this case you must do **either** of the following:
  - Use a powered hub between the laptop and the camera.
  - Install a PCMCIA IEEE 1394 adapter card in the laptop that connects to an external power supply.

- An IEEE 1394 cable

  A standard, 9-pin shielded IEEE 1394b to 1394b cable should be used. The maximum length between the camera and the computer or the hub is 4.5 m.

  If you want to connect the camera to an IEEE 1394a device, as applies to most laptops, you must use a conversion cable. The cable has a 9-pin IEEE 1394b plug on the end that connects to the camera and a 6-pin IEEE 1394a plug on the end that connects to the computer or the powered hub.

- An I/O cable

  The I/O cable must be shielded and constructed of twisted pair wire. The maximum length is at least 10 m.

  The end of the I/O cable that connects to the camera must be terminated with a 12-pin Hirose micro plug (part number HR10A-10P-12S, available from Basler) or the equivalent. The cable must be wired to conform with the camera's I/O connector pin assignments.

  For more information about the I/O connector pin assignments, see Section 4.2.2 on page 69.

- The BCAM 1394 driver software package. The package includes the BCAM 1394 Driver

  version 1.9 or higher, the BCAM Viewer, the BCAM Topology Viewer and the Microsoft AMCAP video capture program.

2.2 Hardware Installation

For the following procedure, we assume that you have prepared all necessary hardware for installation (see the preceding section).

1. Make sure the following requirements are met:
   - The IEEE 1394 adapter in the computer is configured to supply sufficient power to the camera.
   - The voltage is in the specified range.
   - The power polarity is correct.

CAUTION

Voltage outside of specified range

If the voltage of the power to the camera is greater than +36 VDC, damage to the camera can result. If the voltage is lower than +8 VDC, the camera may operate erratically.

Make sure that you keep the voltage between +8 and +36 VDC.

CAUTION

Incorrect power polarity

Reversing the polarity of the power will damage the camera.

The polarity of the power to the camera must conform to the polarities of the IEEE 1394 socket. **Do not** reverse the power polarity.

For more information see the Physical Interface section of this manual.

2. Mount a C-mount lens on the camera making sure the lens is screwed into the lens adapter of the camera as far as it will go.
3. Plug the 9-pin plug of an IEEE 1394 cable into the IEEE 1394b socket of the camera. Choose the cables and plugs according to the actual devices that will be linked to the camera:
   - The camera can be connected to a PC or to a laptop computer.
   - The computer may be IEEE 1394b or IEEE 1394a compliant.
   - Power can be supplied to the camera in different ways.

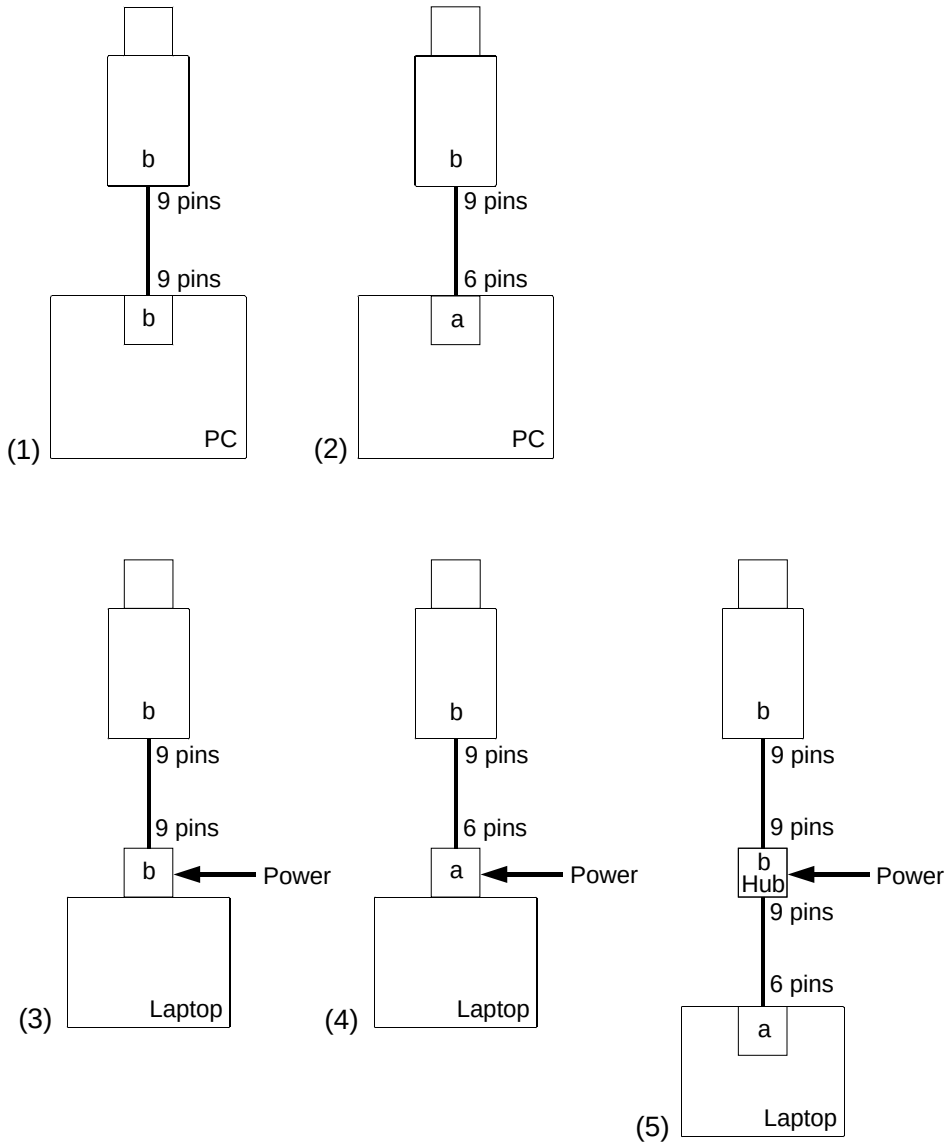


Fig. 26: Different Examples for Linking the IEEE 1394b Compliant Camera to a Computer

(1) Camera linked to a PC equipped with an IEEE 1394b compliant adapter. The camera receives power from the PC. Required cable: 1394b to 1394b.

(2) Camera linked to a PC equipped with an IEEE 1394a compliant adapter. The camera receives power from the PC. Required cable: 1394b to 1394a.

(3) Camera linked to a laptop computer equipped with a powered IEEE 1394b compliant adapter card. Required cable: 1394b to 1394b.

(4) Camera linked to a laptop computer equipped with a powered IEEE 1394a compliant adapter card. Required cable: 1394b to 1394a.

(5) Camera linked to a powered IEEE 1394b compliant hub which is linked to a laptop computer with an IEEE 1394a compliant adapter. Required cables: 1394b to 1394b and 1394b to 1394a.

4. Plug the other end of the cable into the computer or hub. If a hub is present, connect the hub to the computer.
5. If you have not already done so, connect the computer and hub, if present, to the main power supply.
6. Boot the computer.

The hardware is installed. You are set to install the software for operating the camera.

1. Avoiding EMI and ESD Problems

The cameras are frequently installed in industrial environments. These environments often include devices that generate electromagnetic interference (EMI) and they are prone to electrostatic discharge (ESD). Excessive EMI and ESD can cause problems with your camera such as false triggering or can cause the camera to suddenly stop capturing images. EMI and ESD can also have a negative impact on the quality of the image data transmitted by the camera.

To avoid problems with EMI and ESD, you should follow these general guidelines:

- Always use high quality shielded cables. The use of high quality cables is one of the best defenses against EMI and ESD.
- Try to use camera cables that are the correct length and try to run the camera cables and power cables parallel to each other. Avoid coiling camera cables. If the cables are too long, use a meandering path rather then coiling the cables.
- Avoid placing camera cables parallel to wires carrying high-current, switching voltages such as wires supplying stepper motors or electrical devices that employ switching technology. **Placing camera cables near to these types of devices may cause problems with the camera.**
- Attempt to connect all grounds to a single point, e.g., use a single power outlet for the entire system and connect all grounds to the single outlet. This will help to avoid large ground loops. (Large ground loops can be a primary cause of EMI problems.)
- Use a line filter on the main power supply.
- Install the camera and camera cables as far as possible from devices generating sparks. If necessary, use additional shielding.
- Decrease the risk of electrostatic discharge by taking the following measures:
  - Use conductive materials at the point of installation (e.g., floor, workplace).
  - Use suitable clothing (cotton) and shoes.
  - Control the humidity in your environment. Low humidity can cause ESD problems.

2.3 Software Installation

For the following procedure, we assume that these requirements have been met:

- You have connected the camera to the computer
- You have a previous version of the Basler BCAM 1394 Driver software package already installed on your computer.

In the following, we will only describe how to upgrade to the newest version of the driver.

You can find further information about the Basler BCAM 1394 Driver software package in the Basler BCAM 1394 Driver Getting Started Guide (DA000516xx). This guide also includes information about the contents of the software package, about installing the software package, and about ensuring that camera and driver are correctly associated within the operating system on your computer.

If you have Windows XP with Service Pack 2 (SP2) installed, we strongly recommend that you carry out a partial SP2 rollback by replacing some of the drivers in SP2 as described below. This enables the full 800 Mbit/s transmission speed of the camera. Otherwise, the camera will only operate at 100 Mbit/s.

For more information about the partial SP2 rollback, see Section 2.3.2 on page 44.

2.3.1 Upgrading the BCAM Driver Software Package

Note

You must upgrade to version 1.9 or higher of the BCAM 1394 Driver.

1. Your Basler IEEE 1394 camera should not be connected to the interface board. If it is, disconnect it now.
2. If you have not already done so, switch on your computer and allow it to boot up.
3. Make sure that all of the programs on your computer are closed.
4. Click the **Start** button. Click **Control Panel**. Double-click **Add or Remove Programs**.
5. When the **Add or Remove Program** window appears, look through the list of programs and find the entry for the BCAM Driver. Highlight the BCAM Driver entry and click the **Remove** button.
6. When a window appears asking if you are sure, click the **Yes** button.
7. When the computer finishes removing the program, close the **Add or Remove Program** window and the **Control Panel** window.
8. Reboot your computer.
9. Insert the Basler BCAM 1394 CD into your CD-ROM drive. After a few moments, a browser window should open. The window will display information about the available versions of the

BCAM Driver and will supply links to start installation of the driver package. If the browser window does not open:

a. Click **Start** and click **Run**.

b. Navigate to your CD drive and find the file called **Start.html** in the root directory on the CD. (When you search for the file, make sure that **All Files** is selected in the **Files of Type** dropdown menu.)

c. Click on the **Start.html** file, click the **Open** button, and click the **OK** button.

10. Read the information in the browser window, find the install link for the version of the driver you want to install, and click on the link. When the **File Download** window appears, click the **Open** button.
11. Your computer may take several minutes to copy files from the CD. Once the copy process is complete, the installation software will begin to run. When you see the **Welcome** window, click the **Next** button.
12. A License Agreement window will open. Accept the agreement and click the **Next** button.
13. A Customer Information window will open. Enter the appropriate information and click the **Next** button.
14. A Setup Type window will open. We recommend that you select **Complete Installation** and then click the **Next** button.

    (If you chose **Custom Installation**, the wizard will allow you to select the parts of the software that you want to install and will allow you to specify an alternate installation directory.)
15. A **Ready to Install** window will open. Click the **Install** button.
16. When the **Please attach your cameras ...** message appears, connect your cameras and then click the **OK** button.
17. When the installation process is complete, an **Install Completed** window will open. Click the **Finish** button.
18. Make sure that the driver has been properly associated with your camera (see the following sections).

2.3.1.1 Ensuring Correct Camera/Driver Association in Windows 2000

1. Right click on the **My Computer** icon on the desktop and a menu will appear. Click on the **Properties** menu item.
2. Click the **Hardware** tab and then click the **Device Manager** button.

   A list of device drivers will appear. Look for an entry called **Basler 1394 Digital Cameras** and click on the plus sign next to the entry. If your camera is properly associated with the BCAM Driver, its model name will appear below the entry for **Basler 1394 Digital Cameras** as shown in Figure 27. If you find this entry as described, you can close the device manager and turn to the Basler BCAM 1394 Driver Getting Started Guide (DA000516xx) for information about using the Camera Viewer program and the Topology Viewer program. You can also access complete online documentation for the driver by clicking: **Start** ⇒ **All Programs** ⇒ **Basler Vision Technologies** ⇒ **BCAM 1394** ⇒ **BCAM 1394 Online Documentation**.

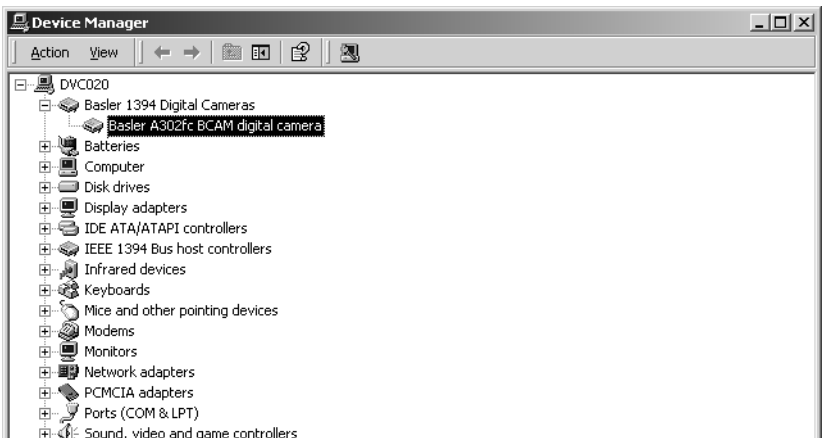


Fig. 27: Correctly Associated Driver

If you did not find an entry for **Basler 1394 Digital Cameras**, the camera is associated with a different driver. An example of this situation is shown in Figure 28. In this example, the camera's model name is listed below an entry for **Generic 1394 Camera**. You might also see the camera listed below an entry for **Imaging Devices**. To correct this situation, go on to step 3.

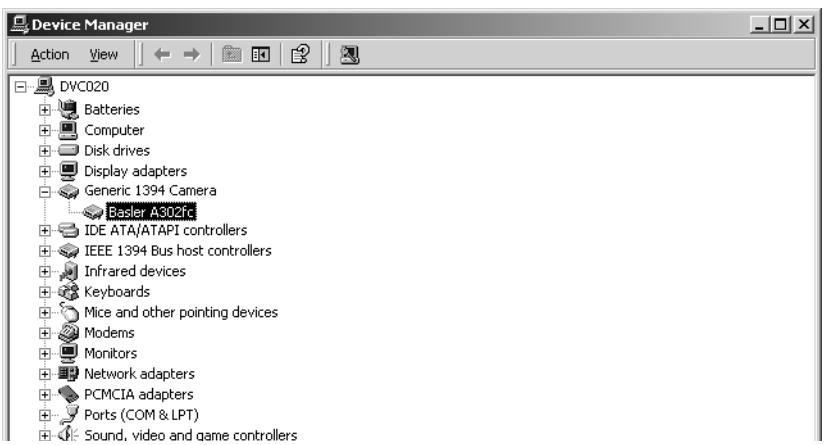


Fig. 28: Incorrectly Associated Driver

3. Right click on the camera's model name and a menu will appear. Click on the **Properties** menu item.
4. Click on the **Driver** tab and then click the **Update Driver** button.
5. An **Upgrade Device Driver** window will open. Click the **Next** button.
6. An **Install Hardware Device Drivers** window will open. Make sure that **Display a list of known drivers ...** is selected and then click the **Next** button.
7. A window showing a list of drivers will open. Select **IEEE 1394 Digital Camera Compliant Specification Camera**. Click the **Next** button.

   (If multiple versions of this driver are available, choose the driver with a version number that matches the version number of the BCAM software you just installed.)
8. The wizard will display a **Start Device Driver Installation** window. Click the **Next** button.
9. The wizard will display a **Completing the Upgrade Device Driver Installation** window. Click the **Finish** button.
10. Close the **Properties** window

    Your camera should now be associated with the correct driver.

You can access complete online documentation for the driver by clicking: **Start** ⇒ **All Programs** ⇒ **Basler Vision Technologies** ⇒ **BCAM 1394** ⇒ **BCAM 1394 Online Documentation**.

You can find information about using the Camera Viewer program and the Topology Viewer program in the Basler BCAM 1394 Driver Getting Started Guide (DA000516xx).

1.

2.3.1.2 Ensuring Correct Camera/Driver Association in Windows XP

1. Right click on the **My Computer** Icon on the desktop and a menu will appear. Click on the **Properties** menu item.
2. Click the **Hardware** tab and then click the **Device Manager** button.

   A list of device drivers will appear. Look for an entry called **Basler 1394 Digital Cameras** and click on the plus sign next to the entry. If your camera is properly associated with the BCAM driver, its model name will appear below the entry for **Basler 1394 Digital Cameras** as shown in Figure 29. If you find this entry as described, you can close the device manager and turn to the Basler BCAM 1394 Driver Getting Started Guide (DA000516xx) for information about using the Camera Viewer program and the Topology Viewer program. You can also access complete online documentation for the driver by clicking: **Start** ⇒ **All Programs** ⇒ **Basler Vision Technologies** ⇒ **BCAM 1394** ⇒ **BCAM 1394 Online Documentation**.

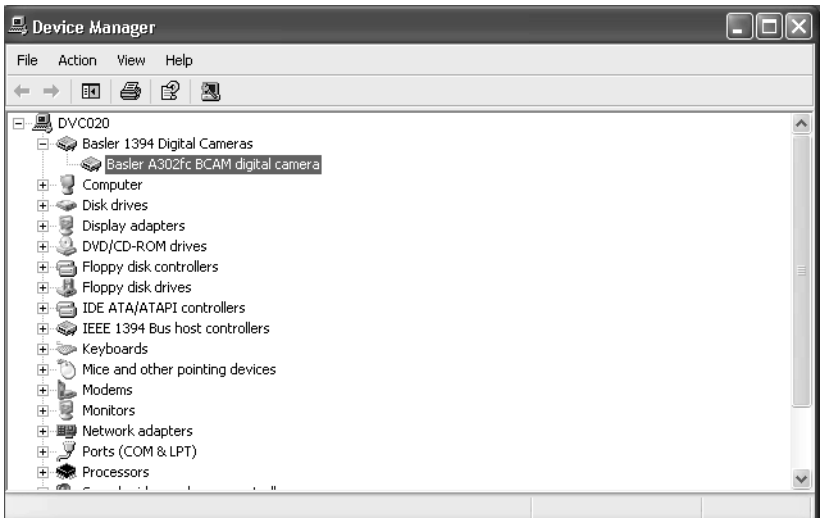


Fig. 29: Correctly Associated Driver

If you did not find an entry for **Basler 1394 Digital Cameras** it means that the camera is associated with a different driver. An example of this situation is shown in Figure 30. In this example, the camera is listed as a **Generic 1394 Desktop Camera** below **Imaging devices**. You might also see the camera listed by its model name below **Imaging devices**. To correct this situation, go on to step 3.

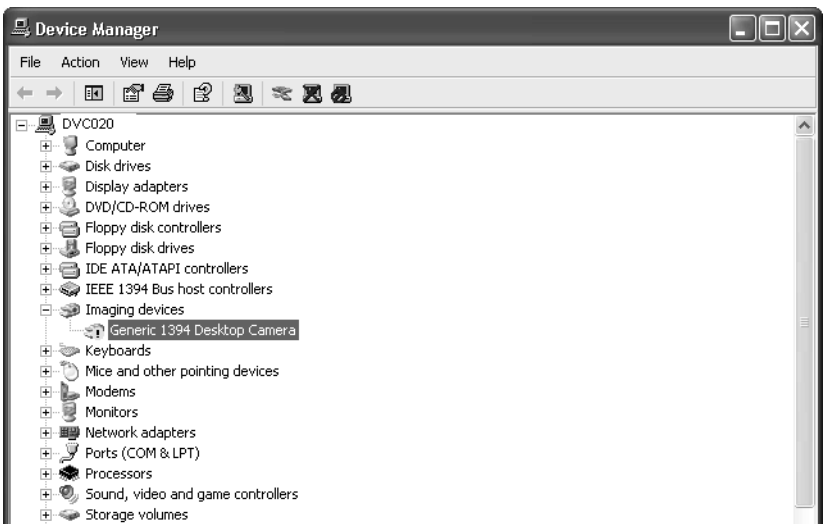


Fig. 30: Incorrectly Associated Driver

3. Right click on **Generic 1394 Desktop Camera** and a menu will appear. Click on the **Update Driver** menu item.
4. A **Hardware Update** Wizard will open.
5. Make sure **Install from a list or specific location** is checked. Click the **Next** button.
6. Make sure **Don't search. I will choose ...** is checked. Click the **Next** button.

7. The wizard will search for drivers. When a list of drivers appears, make sure that **IEEE-1394 Digital Camera Specification Compliant Camera** is highlighted. Click the **Next** button.

   (If multiple versions of this driver are available, choose the driver with a version number that matches the version number of the BCAM software you just installed.)

8. The wizard will install the driver and will display a **Completing** window. Click the **Finish** button.

   Your camera should now be associated with the correct driver.

You can access complete online documentation for the driver by clicking: **Start** ⇒ **All Programs** ⇒ **Basler Vision Technologies** ⇒ **BCAM 1394** ⇒ **BCAM 1394 Online Documentation**.

You can find information about using the Camera Viewer program and the Topology Viewer program in the Basler BCAM 1394 Driver Getting Started Guide (DA000516xx).

2.3.2 Partial SP2 Rollback

If you have Windows XP with Service Pack 2 (SP2) installed on your PC, we strongly recommend that you carry out a partial SP2 rollback by replacing certain drivers in SP2 with drivers from SP1 as described below. This enables the full 800 Mbit/s transmission speed of the camera. Otherwise, the camera will only operate at 100 Mbit/s.

To carry out the partial SP2 rollback, you need administrator rights on your computer and Windows Explorer must be configured to show hidden files and folders (see below).

If you have XP with SP2 and you only need a transmission speed of 400 Mbit/s, you can apply a Windows XP update instead of carrying out the partial SP2 rollback. See the following URL for further information on the Windows XP update and for downloading the update:
http://support.microsoft.com/kb/885222

If you have Windows XP and **only** have Service Pack 1 (SP1) installed, the rollback procedure described below is not relevant for you. Your camera will operate at an 800 Mbit/s transmission speed without making any modifications to the operating system.

Note

If you only have SP1 is installed, hot plug capability is not available.

Hot plug capability normally becomes available when SP 2 is installed. But after carrying out the partial SP2 rollback, hot plug capability will no longer be available.

If you don't have hot plug capability (i.e., if you only have SP1 installed or if you have SP2 installed and you have done the rollback), you should not plug or unplug a camera from the PC while the camera is capturing images. Plugging or unplugging a camera while it is capturing images might result in a blue screen error on the PC. Plugging or unplugging a camera while it is idle is OK, even without hot plug capabilities.

You can resolve the hot plug problem by installing a hot fix. See the following URL for further information and for obtaining the hot fix:
http://support.microsoft.com/kb/811789

Note

After you carry out the partial SP2 rollback, the result of the rollback will be lost if you:

- Install a new IEEE 1394 host controller
- Change the existing host controller to a different slot in the PC

In either case, you should carry out the partial SP2 rollback again.

To Configure Windows Explorer to Show Hidden Files and Folders

1. If you have not already done so, open Windows Explorer in your computer.
2. Click the **Tools** menu.
3. Click **Folder Options...** in the drop down menu.
4. Click the **View** tab.
5. Select the option button beside **Show hidden files and folders**.
6. Click **OK**.

   Windows Explorer is configured to show hidden files and folders.

To Carry Out the Partial SP2 Rollback

1. Disconnect **all** IEEE 1394 devices from the connectors on the computer.
2. Open Windows Explorer and navigate to the **Windows** directory and create an **sp2_rollback** directory.
3. Navigate to the **Windows\sp2_rollback** directory and create an **i386** directory.
4. Navigate to the **Windows\inf** directory and copy the **1394.inf** file into the **sp2_rollback** directory.
5. What you do in this step depends on which Windows XP service packs are already installed on your computer:
   - If SP2 is installed on your host PC but not SP1, you must download the complete SP1 package in order to obtain the drivers from SP1 that will replace the drivers in SP2:
     a. Download the "Windows XP Service Pack 1a Network Installation" from the following URL:

        http://www.microsoft.com/windowsxp/downloads/updates/sp1/network.mspx

     b. Open the command prompt.
     c. Navigate to the downloaded SP1.
     d. Execute the following command to create an **sp1_files** subdirectory and extract files from SP1 into the subdirectory: **xpsp1a_en_x86.exe /U /X:sp1_files**
     e. Execute the following commands to decompress the required drivers and copy them into the **Windows\sp2_rollback** directory:

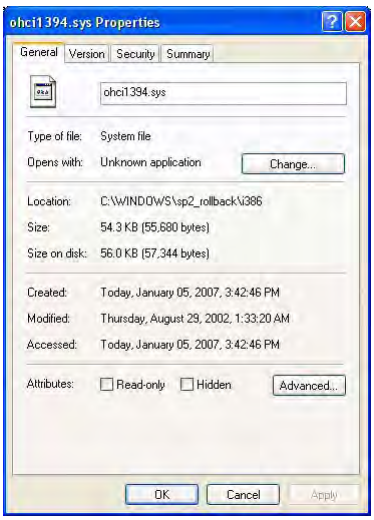
        expand sp1_files\1394bus.sy_ %windir%\sp2_rollback\i386\1394bus.sys and

        expand sp1_files\ohci1394.sy_ %windir%\sp2_rollback\i386\ohci1394.sys

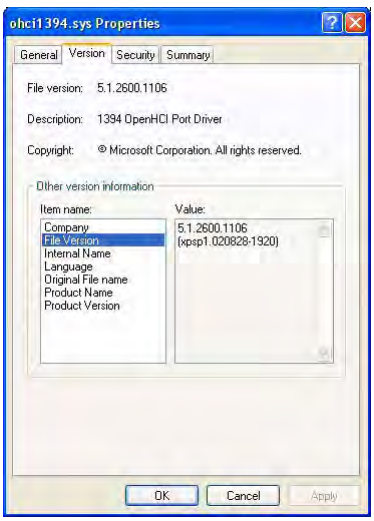
     f. Exit the command prompt.

   - If SP1 and SP2 are both installed on your Host PC:
     a. Navigate to the **Windows\Driver Cache\i386** directory.
     b. Double-click on **sp1.cab**.
     c. Copy the **ohci1394.sys** and **1394bus.sys** files into the **Windows\sp2_rollback\i386** directory.

6. Navigate to the **Windows\sp2_rollback\i386** directory:
   a. Right click on the **ohci1394.sys** file and select **Properties** from the drop down menu. An **ohci1394.sys Properties** window opens as shown below.

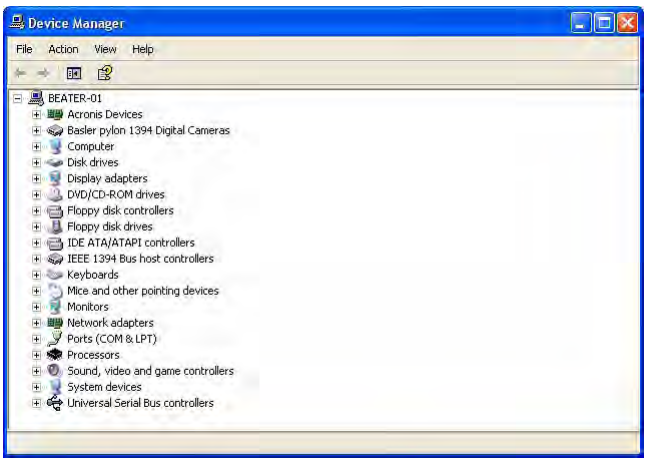


   b. Click the **Version** tab.
   c. In the **Item Name** box, click on the **File Version** item. Make note of the file version information that appears in the **Value** box as shown below. You will need this information later in the procedure.

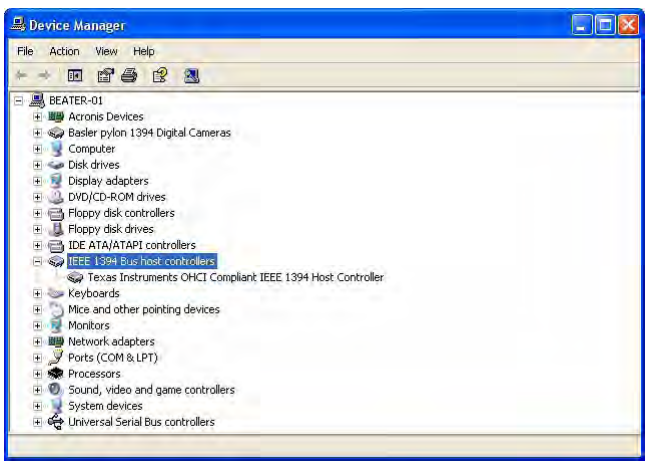


   d. Click the **OK** button.
   e. Right click on the **1394bus.sys** file and select **Properties** from the drop down menu. An **1394bus.sys Properties** window opens.
   f. Click the **Version** tab.
   g. In the **Item Name** box, click on the **File Version** item. Make note of the file version information that appears in the **Value** box. You will need this information later in the procedure.
   h. Click the **OK** button.

7. Navigate to the **Windows\system32\drivers** directory and copy the **arp1394.sys**, **enum1394.sys**, and **nic1394.sys** files into the **Windows\sp2_rollback\i386** directory.
8. Navigate to the **Windows\Driver Cache\i386** directory and rename **sp2.cab** to **sp2_inactive.cab.** This will disable the Windows File Protection feature that allows the installation of only the latest versions of drivers.
9. Open the **Device Manager** window by doing the following:
   a. Click **Start** and click **Run**.
   b. When the **Run** window opens, type in: devmgmt.msc
   c. Click the **OK** button.
   d. The Device Manager window will open as shown below.



10. In the **Device Manager** window, double-click **IEEE 1394 Bus host controllers**.
    The **IEEE 1394 Bus host controllers** node will expand as shown below.
    a. Double-click the firewire controller (e.g. ***OHCI***) you want to use with the camera.



11. The **Host Controller** window for the selected firewire host controller will open as shown below.
    a. Click the **Driver** tab.
    b. Click the **Update Driver** button.

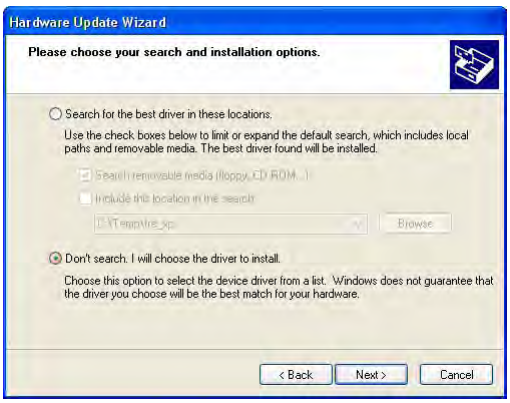
12. A **Hardware Update Wizard** window will open.
    a. Select **No, not this time** as shown below
    b. Click the **Next** button.

Hardware Update Wizard
Welcome to the Hardware Update Wizard
Windows will search for current and updated software by looking on your computer, on the hardware installation CD, or on the Windows Update Web site (with your permission).
Read our privacy policy
Can Windows connect to Windows Update to search for software?
Yes, this time only
Yes, now and every time I connect a device
No, not this time
Click Next to continue.
< Back
Next >
Cancel

13. A new **Hardware Update Wizard** window will open.
    a. Select **Install from a list or specific location** as shown below.
    b. Click the Next button.

Hardware Update Wizard
This wizard helps you install software for:
Texas Instruments OHCI Compliant IEEE 1394 Host Controller
If your hardware came with an installation CD or floppy disk, insert it now.
What do you want the wizard to do?
Install the software automatically (Recommended)
Install from a list or specific location (Advanced)
Click Next to continue.
< Back
Next >
Cancel

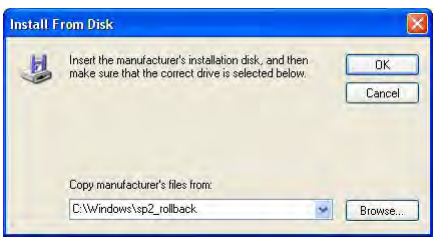
14. A new **Hardware Update Wizard** window will open.
    a. Select the **Don't search, I will choose the driver to install** as shown below.
    b. Click the **Next** button.


Hardware Update Wizard
Please choose your search and installation options.
Search for the best driver in these locations.
Use the check boxes below to limit or expand the default search, which includes local paths and removable media. The best driver found will be installed.
Browse
Don't search. I will choose the driver to install.
Choose this option to select the device driver from a list. Windows does not guarantee that the driver you choose will be the best match for your hardware.
< Back
Next >
Cancel

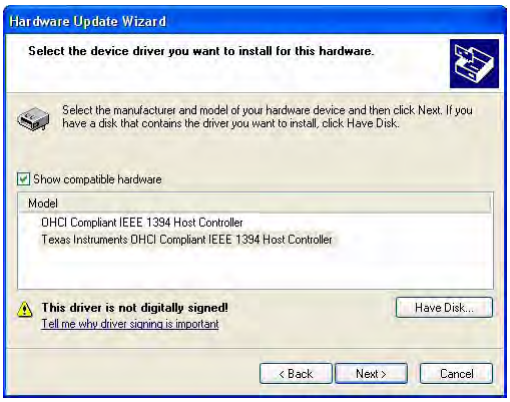
15. A new **Hardware Update Wizard** window will open as shown below.
    a. Make sure the check box beside **Show compatible hardware** is checked and click the **Have Disk** button.

Hardware Update Wizard
Select the device driver you want to install for this hardware.
Select the manufacturer and model of your hardware device and then click Next. If you have a disk that contains the driver you want to install, click Have Disk.
Show compatible hardware
Model
OHCI Compliant IEEE 1394 Host Controller
Texas Instruments OHCI Compliant IEEE 1394 Host Controller
This driver is digitally signed.
Tell me why driver signing is important
Have Disk...
< Back
Next >
Cancel

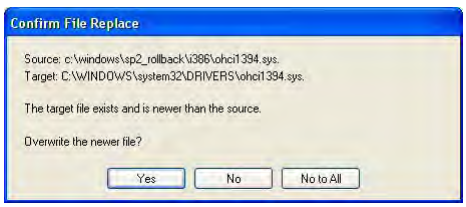
16. The **Install From Disk** window will open.
    a. Type in: C:\Windows\sp2_rollback as shown below.
    b. Click the **OK** button.



17. A **Hardware Update Wizard** window will open.
    a. Make sure the check box in front of **Show compatible hardware** is checked as shown below.
    b. Click the **Next** button.


Hardware Update Wizard
Select the device driver you want to install for this hardware.
Select the manufacturer and model of your hardware device and then click Next. If you have a disk that contains the driver you want to install, click Have Disk.
Show compatible hardware
Model
OHCI Compliant IEEE 1394 Host Controller
Texas Instruments OHCI Compliant IEEE 1394 Host Controller
This driver is not digitally signed!
Tell me why driver signing is important
Have Disk...
< Back
Next >
Cancel

18. If a **Confirm File Replace** window similar to the one shown below opens:
    a. Ignore the message about the **ohci1394.sys** file and click the **Yes** button.
    (If a similar message appears for other files, click the **Yes** button each time.)



19. If a **Hardware Installation** window similar to the one shown below opens:
    a. Ignore the error message and click the **Continue anyway** button.
    Depending on the number of IEEE 1394 host controllers installed on your computer, you may have to repeat this step several times.

Hardware Installation
The software you are installing for this hardware:
Texas Instruments OHCI Compliant IEEE 1394 Host Controller
has not passed Windows Logo testing to verify its compatibility with Windows XP. (Tell me why this testing is important.)
Continuing your installation of this software may impair or destabilize the correct operation of your system either immediately or in the future. Microsoft strongly recommends that you stop this installation now and contact the hardware vendor for software that has passed Windows Logo testing.
Continue Anyway
STOP Installation

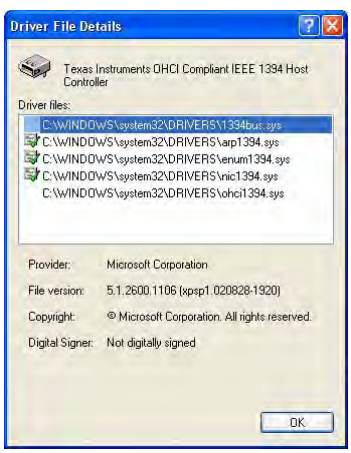
20. A new **Hardware Update Wizard** window opens.
    a. Click the **Finish** button.

Hardware Update Wizard
Completing the Hardware Update Wizard
The wizard has finished installing the software for:
Texas Instruments OHCI Compliant IEEE 1394 Host Controller
Click Finish to close the wizard.
< Back
Finish
Cancel

21. Verify the partial SP2 rollback:
    a. The **Host Controller** window should still be open. If it is not, navigate to the **Host Controller** window of the firewire host controller as described in steps 9 to 11.

Texas Instruments OHCI Compliant IEEE 1394 Host Co...
General
Driver
Details
Resources
Texas Instruments OHCI Compliant IEEE 1394 Host Controller
Device type: IEEE 1394 Bus host controllers
Manufacturer: Texas Instruments
Location: PCI Slot 3 (PCI bus 0, device 15, function 0)
Device status
This device is working properly.
If you are having problems with this device, click Troubleshoot to start the troubleshooter.
Troubleshoot...
Device usage:
Use this device (enable)
OK
Cancel

    b. Click the **Driver** tab and click the **Driver Details** button. The **Driver File Details** window opens as shown below.



c. Updated **ohci1394.sys** and **1394bus.sys** files were installed during partial SP2 rollback. Click the **ohci1394.sys** and **1394bus.sys** files to display the versions of the files.

   The partial SP2 rollback was successful if the displayed version numbers are identical to the version numbers for the **ohci1394.sys** and **1394bus.sys** files that you noted in step 6.

d. Click the **OK** button.

e. Close the **Host Controller** window.

22. If you have more than one firewire controller on your computer (e.g., the **Device Manager** window in step 10 shows two or more firewire controllers), repeat step 21 to check whether the partial SP2 rollback was also carried out for the additional controllers.

    If you find that the partial SP2 rollback was not carried out for a firewire controller, repeat steps 11 to 21 for that firewire controller.

23. Do the following to undo step 8 and to enable the Windows File Protection feature:

    a. Navigate to the **Windows\Driver Cache\i386** directory.

    b. Rename **sp2_inactive.cab** to **sp2.cab**.

24. Close all open windows.

The partial SP2 rollback is complete. You can now reconnect your IEEE 1394 devices to the computer.

2.4 Acquiring Your First Images

To acquire and view your first images, use the BCAM Viewer. You can control the camera via the BCAM Viewer that is supplied with the Basler BCAM1394 Driver software package or via an API from your system control software. We recommend that you use the BCAM Viewer for controlling the camera when acquiring your first images.

The following steps assume you are using the BCAM Viewer. At this stage, some of the camera settings are likely to be preliminary. Subsequent sections of the User's Manual will help you improve image quality and to arrive at the final camera settings to suit the requirements of your application.

Before starting, make sure that the latest versions of the camera's driver and viewer are installed, that a lens is mounted on the camera, that the camera is connected to the computer, that the computer is running, and that the camera is receiving power.

For more information about the Basler BCAM1394 Driver software package and the API, see Section 5 on page 83.

If, during the following steps, you encounter problems that are not covered in this section, see Section 12 on page 289.

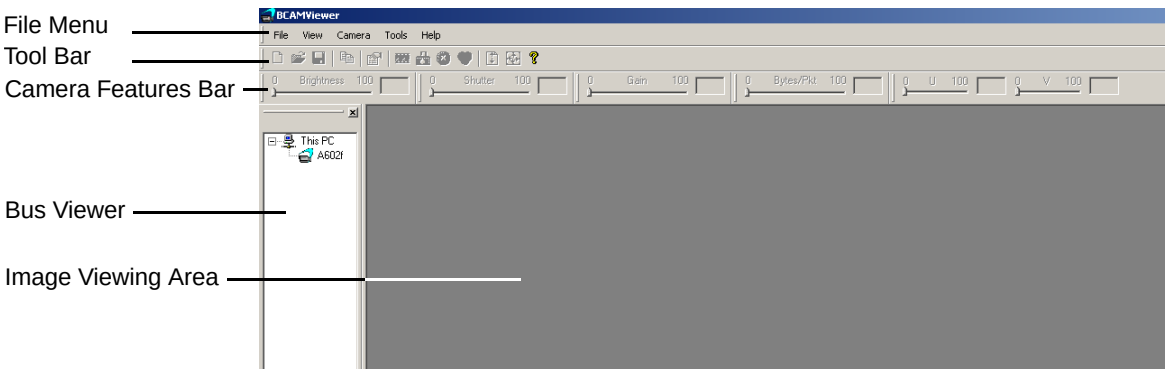
1. Put an object within the camera's field of view.

   Note: If you are using a color camera, the object should display a uniform gray and fill the camera's entire field of view for optimum white balance (see below).

2. Make sure the object is illuminated. Use continuous illumination for the initial setup. If you want to use strobe light in your application, make the necessary adjustments later. Contact Basler Technical Support if you need assistance in determining the optimum illumination for your application.

3. Click the BCAM Viewer icon on the computer desktop to start the BCAM Viewer.

   The **BCAMViewer** window opens.

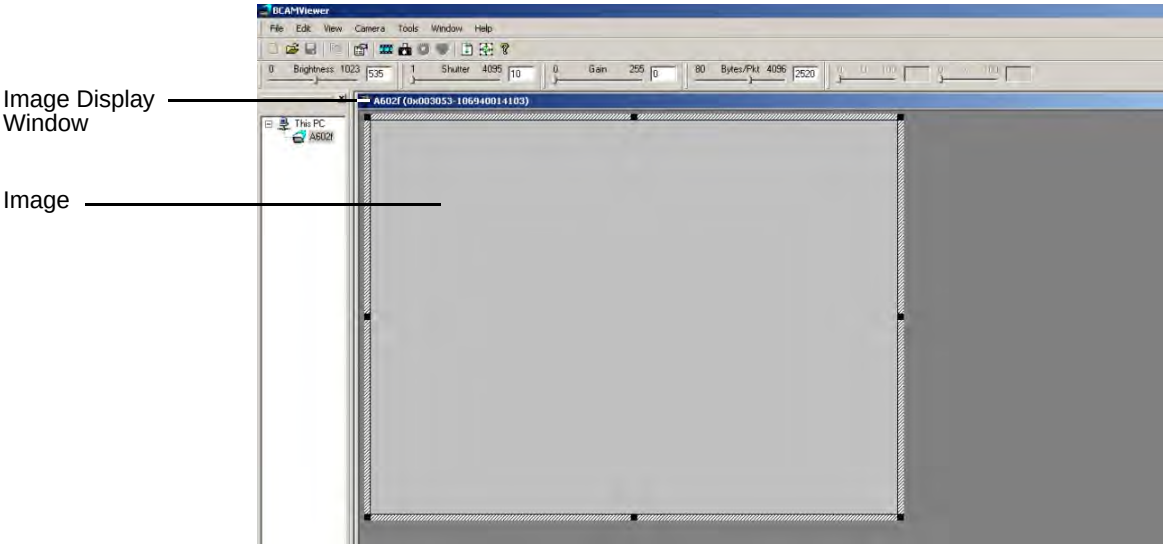


   A 1394 bus tree is displayed in the bus viewer. All devices attached to the bus, including your camera, are indicated.

   Note: For detailed information on the BCAM Viewer click the **Help** button in the file menu and select **Help Topics** in the drop down menu or press the **F1** key to open the viewer's online help.

4. Double click the camera's icon in the bus viewer to select the camera.

   An image display window opens in the image viewing area.



5. The hatched border around the image indicates that the camera is set to video Format 7. The border represents the extents of the camera's area of interest (AOI). By default, the AOI is set to the full resolution of the camera.

   If the camera is not set to Format 7:

   a. Click the **View** button in the file menu.
   b. Click **Properties** in the drop down menu.
   c. Click the **Video Format** tab.
   d. Select **Format 7** in the **Video Format** group.
   e. Click **OK**.

6. To adjust image quality, you will make adjustments on the camera's lens and in the viewer. For some adjustments in the viewer, you can use sliders or enter values directly into edit fields in the camera features bar.

   If you do not yet know the camera settings for optimum image brightness and contrast, choose the following preliminary settings:

   a. Open the lens aperture "half way" by choosing an intermediate f-number.
   b. Set the **Brightness** in the BCAM Viewer to a value between 16 and 32.
   c. Set the **Shutter** in the BCAM Viewer to the lowest value.
   d. Set the **Gain** in the BCAM Viewer to the lowest value.

7. Click the icon in the tool bar or click the **Camera** button in the file menu and select **Continuous Grab** in the drop down menu.

   The camera acquires images continuously. The images are displayed and continuously updated in the image display window.

   With the current camera setting the images will probably be very dark or perhaps black.

   The following steps assume that the current images are too dark. If the current images are too bright, dim the illumination or close the lens aperture.

8. Increase the **Shutter** to increase the image brightness to almost the desired level. If you want to image a moving object make sure to avoid motion blur by choosing a sufficiently low shutter setting (see the following section for details).
9. If required, slightly increase the **Gain** to improve contrast.

   Note: Make sure that detail is still visible in the brightest portions of the image. Note also that noise is increased by increasing gain.
10. Focus the image.
11. Adjust the lens aperture to obtain the required depth of focus and to set the image brightness to the desired level (see the following section for details).
12. Slightly adjust the **Brightness** to ensure that detail is still visible in the darkest portions of the image (see the following section for details). If you are using a higher than 8 bit video output mode you should avoid brightness settings above 64.
13. Adjust **Shutter**, **Gain**, and **Brightness** (in this order) to further improve the image.
14. If you are using a color camera, perform an automatic white balance.

    Note: The object in the field of view should display a uniform gray and fill the camera's entire field of view for optimum white balance.
    a. Click the **View** button in the file menu.
    b. Click **Properties** in the drop down menu.
    c. Click the **Video Format** tab.
    d. Select **YUV(4:2:2)** in the **Color Coding** group if it is not already selected.
    e. Click **OK**.
    f. Click the icon in the tool bar for automatic white balance.
15. If you are using a color camera, choose the setting that matches the alignment of the Bayer filter of your camera:
    a. Click the **View** button in the file menu.
    b. Click **Properties** in the drop down menu.
    c. Click the **Video Format** tab.
    d. Select **Raw8** in the **Color Coding** group.
    e. Click **OK**.
    f. Click the **View** button in the file menu.
    g. Select **Bayer to RGB Conversion** in the drop down menu.
    h. Of the four **Enabled (xxxx)** buttons (e.g. **Enabled (GBRG)**) select the one that results in correct colors in the image.
16. Fine tune the settings to improve the image quality. Refer to the following section for information on improving image quality.

17. Having determined the camera settings for optimum image quality save the camera settings for future use.

    Note: If the camera is currently acquiring images continuously, you can not save the camera settings. Click the icon in the tool bar to stop continuous image acquisition.

    To save the camera settings:

    a. Click the **File** button in the file menu.
    b. Select **Save Camera Settings** in the drop down menu.
       A standard Windows **Save As** dialog box appears.
    c. Navigate to your desired destination and enter the desired file name.
    d. Click the **Save** button.
       As a default, the settings are saved in a file with a **.cfg** extension.

2.5 Adjusting the Image Quality

In the following descriptions, we will discuss image quality in terms of focus, depth of focus, brightness and contrast. You can adjust image quality with regard to these criteria by choosing appropriate settings. However, the "best" image quality will partly depend on the specific requirements of your application and therefore no generally applicable "best" setting can be recommended.

The adjustments will involve the following:

- adjusting the brightness of the illumination
- adjusting the focus
- setting the lens aperture
- setting the brightness
- setting the shutter
- setting the gain
- adjusting white balance.

In addition, the quality of an image will be affected by other factors, e.g., by the choice of the lens.

We recommend carrying out all fine adjustments using the illumination and the settings for video format, video mode, and color coding that you want to use in your application.

Focus:

You will obtain a focused image only if the lens is screwed into the lens adapter of the camera as far as it will go and if the glass surfaces are clean. The object to be imaged must be within the range of focus of the lens.

- You can obtain a focused image by turning the focal ring of the lens.

Depth of Focus:

If the objects you want to image are located at different distances from the camera, you must consider depth of focus. The depth of focus must be sufficiently deep to allow all objects to appear focused in the image.

- You can change the depth of focus by turning the aperture ring of the lens. Closing the lens aperture (turning the aperture ring to higher f-numbers) increases the depth of focus and vice versa.

  Note: Closing the aperture decreases the amount of light reaching the camera’s sensor and therefore results in a darker image.

Brightness:

Note: We will use the term "brightness" in a twofold sense. "Brightness" will be used in the generic sense as the property of an image that is, e.g., determined by the intensity of the illumination resulting in a brighter or darker image. "Brightness" will also refer to a setting that modifies the pixel readout resulting in a brighter or darker image. With this method, a constant gray value is added to or subtracted from the readout of each pixel.

Among the factors determining the brightness of an image are the intensity of the illumination, the setting of the lens aperture, and the settings for brightness, shutter, and gain.

- We recommend that you choose bright illumination if possible, but avoid excessive intensity. This will prevent you from needing to operate the camera using extreme camera settings. A bright but not excessively bright illumination is of central importance to achieving good image quality.
- In images acquired from CCD sensors, excessive brightness will cause artifacts such as smear (white stripes in the image) and blooming (local over-saturation destroying contrast). You can decrease the proneness for smear and blooming by choosing a diffuse and less intense illumination and by modifying the sensor readout using the lookup table smart feature.
- If illumination of sufficient brightness is not available, you can select a lens that is optimized for light utilization.
- Opening the lens aperture will allow more light to reach the camera’s sensor and will therefore increase the brightness of the image.

  Note: Opening the lens aperture also increases the effects of optical aberrations. This causes image distortions and the intensity of light decreases towards the edges of the sensor (vignetting). In addition, the depth of focus decreases.
- You can change the brightness of the image by changing the camera’s brightness setting. Normally, you should increase the brightness setting only as far as is necessary to make detail visible in the darkest portions of an image. (This is equivalent to avoiding the clipping of the low gray values of noise.)

  Note: High brightness settings will prevent high contrast. We recommend not using brightness settings above 64 (at greater than 8 bit output).
- You can increase the brightness of the image by increasing the camera’s shutter setting. With this method, brightness is determined by the exposure time and thus by the amount of photons collected for pixel readout.

  Note: Increasing the shutter setting may decrease the frame capture rate. If you are capturing images of moving objects, increasing the shutter setting may increase motion blur.
- Increasing the gain will also increase image brightness.

  Note: Unless your application requires extreme contrast, make sure that detail remains visible in the brightest portions of the image when increasing gain. Note also that noise is increased by increasing gain.

Shutter:

The shutter setting determines the time interval during which the sensor is exposed to light.

- Choose a shutter setting that takes account of whether you want to image still or moving objects:
  - If the object is not moving you can choose a high shutter setting (i.e. a long exposure interval).

    Note: High shutter settings may reduce the frame rate and may cause artefacts appearing in the image.
  - If the object is moving, choose a low shutter setting to prevent motion blur. As a general rule, choose a short exposure interval to make sure the image of the object does not move by more than one pixel during exposure.

Gain:

Gain multiplies each pixel readout by a certain factor. Accordingly, signal and noise are amplified.

Note: It is not possible to improve the signal-to-noise ratio by increasing gain.

- You can increase the contrast of the image by increasing the camera's gain setting.
- Increasing gain will increase the image brightness.

  Note: Unless your application requires extreme contrast, make sure that detail remains visible in the brightest portions of the image when increasing gain. Note also that noise is increased by increasing gain.
- Set the gain only as high as is necessary.

Contrast:

Strong contrast in an image is obtained when objects of different brightnesses are represented by strongly different grey values. For most applications, optimum contrast is reached when the image displays a wide range of gray values with fine detail remaining visible even in the darkest and brightest parts of an image. Some applications, however, may require extreme contrast.

- You can increase the contrast of the image by increasing the camera's gain setting. Gain multiplies the pixel readout.
- High brightness settings will prevent high contrast. We recommend not using brightness settings above 64 (at greater than 8 bit output).
- In images acquired from CCD sensors, contrast can be destroyed by local over-saturation (blooming) if the brightness is too high. You can decrease the proneness for smear and blooming by choosing a diffuse and less intense illumination and by modifying the sensor readout using the lookup table smart feature.
- Closing the lens aperture not only decreases brightness but also increases contrast towards the edges of an image.
- If you must use insufficient illumination resulting in dark images, you may notice the blurring influence of noise. If you operate the camera near the high end of the specified temperature range, the effects may be particularly noticeable. You can increase contrast by lowering the operating temperature of the camera.

Note: It is not possible to improve the signal-to-noise ratio by increasing gain. Increasing the gain will increase signal and noise by equal proportions.

White balance:

- If you are using a color camera, the object that you use when adjusting the white balance should be a uniform gray and should fill the camera's entire field of view. Your white balance will be correct when images of this object show a uniform gray.
- Changing the brightness setting will change the white balance. We therefore recommend that you carry out white balance after setting the brightness.
- Make sure the image is neither underexposed nor overexposed when carrying out white balance.

Next Steps

We assume that you succeeded in acquiring images and controlling the camera using the viewer and that you were able to optimize the image quality.

To meet the requirements of your application, you will likely need to make additional camera settings and modify previous camera settings.

See the sections in this manual on operation, standard features, and smart features for details about additional camera settings. See the BCAM documentation for information on how to enable and set the camera settings. We recommend controlling the camera via the BCAM API when taking the next steps.

Contact Basler Technical Support if you need further assistance. The contact numbers appear on the title page of this manual.

If you have not already done so, implement the typical conditions of operation as required by your application before proceeding with the next steps. In particular, choose the lens and the illumination required by your application.

Before making the additional camera settings, you must know exactly what the requirements of your application are such as depth of focus, frame rate, size of the AOI, and contrast. And you must know what the priorities of the requirements are since some of the settings depend on each other or have opposite effects. For example, a desired high frame rate may not be reachable with the exposure time set to a high value or with the area of interest set to full resolution.

The next steps involve all or some of the following:

- Selecting the video format, mode, color coding, and frame rate
- Defining an AOI
- Controlling exposure by selecting a trigger scheme and by setting the exposure time. If you use an external device to supply the trigger, you must also connect the camera to the external device using the I/O cable.
- Controlling the frame rate by using the Frame Rate parameter or with trigger signals and the Bytes Per Packet parameter to obtain the required frame capture rate. If you are using more

than one camera on the same bus, choose the settings to make optimum use of the available bus bandwidth.

- Defining strobe control output signals
- Enabling and parameterizing smart features.

3 Functional Description

This section provides an overview of the camera's functionality from a system perspective. The overview will aid your understanding when you read the more detailed information included in the next sections of the user's manual.

3.1 Overview (All Models Except scA750-60)

Note

The information in this section applies to all camera models except the scA750-60 fm/fc. For information about scA750-60 cameras, see Section 3.2 on page 65.

Each camera provides features such as a full frame shutter and electronic exposure time control.

Exposure start, exposure time, and charge readout can be controlled by parameters transmitted to the camera via the API and the IEEE 1394b interface. There are also parameters available to set the camera for single frame capture or continuous frame capture.

Exposure start can also be controlled via an externally generated hardware trigger (ExTrig) signal. The ExTrig signal facilitates periodic or non-periodic image capture. Modes are available that allow the length of exposure time to be directly controlled by the ExTrig signal or to be set for a pre-programmed period of time.

Accumulated charges are read out of the sensor when exposure ends. At readout, accumulated charges are transported from the sensor's light-sensitive elements (pixels) to the vertical shift registers (see Figure 31 on page 64). The charges from the bottom line of pixels in the array are then moved into a horizontal shift register. Next, the charges are shifted out of the horizontal register. As the charges move out of the horizontal shift register, they are converted to voltages proportional to the size of each charge. Each voltage is then amplified by a Variable Gain Control (VGC) and digitized by an Analog-to-Digital converter (ADC). After each voltage has been amplified and digitized, it passes through an FPGA and into an image buffer. All shifting is clocked according to the camera's internal data rate. Shifting continues in a linewise fashion until all image data has been read out of the sensor.

The pixel data leaves the image buffer and passes back through the FPGA to an IEEE1394b link layer controller where it is assembled into data packets. The packets are passed to a 1394b physical layer controller which transmits them isochronously to an interface board in the host PC. The physical and link layer controllers also handle transmission and receipt of asynchronous control data such as changes to the camera's parameters.

The image buffer between the sensor and the link layer controller allows data to be read out of the sensor at a rate that is independent of the data transmission rate between the camera and the host computer. This ensures that the data transmission rate has no influence on image quality.

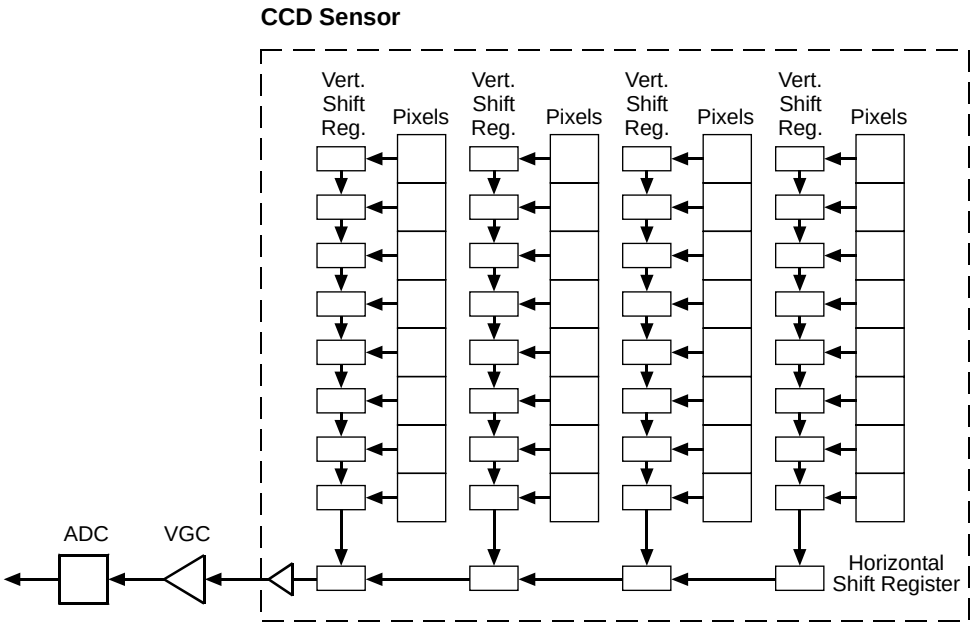


Fig. 31: CCD Sensor Architecture

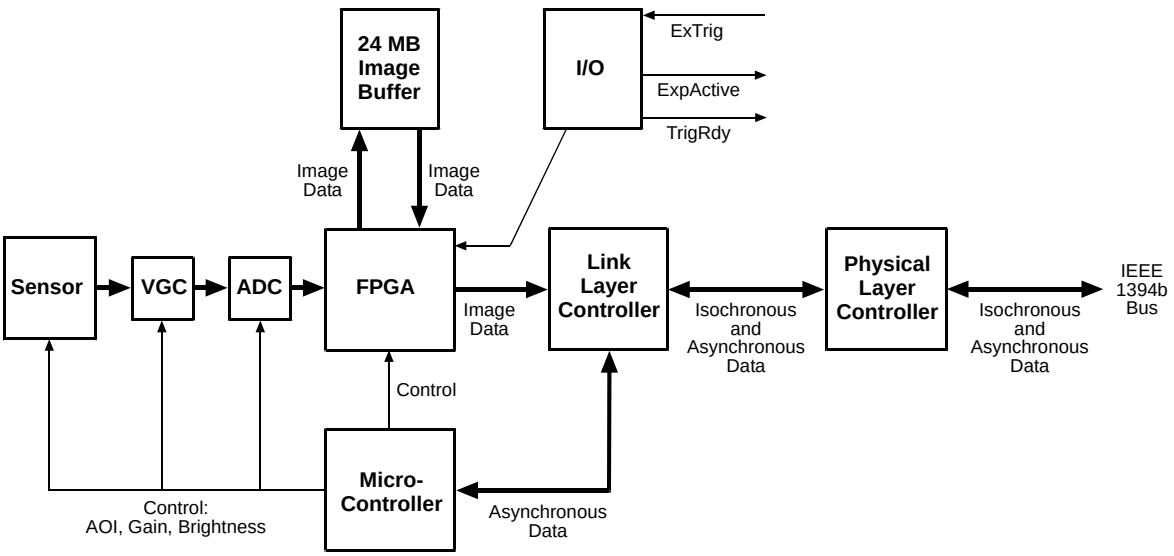


Fig. 32: Camera Block Diagram

3.2 Overview (scA750-60 Only)

Note

The information in this section only applies to scA750-60 fm/fc cameras. For information about the other camera models, see Section 3.1 on page 63.

Each camera provides features such as a full frame shutter and electronic exposure time control. The CMOS sensor chip includes gain controls, ADCs, and other digital devices.

Exposure start, exposure time, and charge readout can be controlled by parameters transmitted to the camera via the API and the IEEE 1394 interface. There are also parameters available to set the camera for single frame capture or continuous frame capture.

Exposure start can also be controlled via an externally generated hardware trigger (ExTrig) signal. The ExTrig signal facilitates periodic or non-periodic start of image capture. Exposure can be set for a preprogrammed period of time.

Accumulated charges are read out when the programmed exposure time ends. At readout, the accumulated charges are transported from the sensor's light-sensitive elements (pixels) to the sensor's column buses (see Figure 31 on page 64). The charges from the bottom line of pixels in the array are then moved into the analog processing section of the sensor. As the charges move from the pixels to the analog processing section, they are converted to voltages proportional to the size of each charge. The voltages from the analog processing section are next passed to a bank of Analog-to-Digital converters (ADCs).

Finally, the voltages pass through a section of the sensor where they receive additional digital processing and then they are moved out of the sensor. As each voltage leaves the sensor, it passes through an FPGA and into an image buffer. All shifting is clocked according to the camera's internal data rate. Shifting continues in a linewise fashion until all image data has been read out of the sensor.

The pixel data leaves the image buffer and passes back through the FPGA to an IEEE1394b link layer controller where it is assembled into data packets. The packets are passed to a 1394b physical layer controller which transmits them isochronously to an interface board in the host PC. The physical and link layer controllers also handle transmission and receipt of asynchronous control data such as changes to the camera's parameters.

The image buffer between the sensor and the link layer controller allows data to be read out of the sensor at a rate that is independent of the data transmission rate between the camera and the host computer. This ensures that the data transmission rate has no influence on image quality.

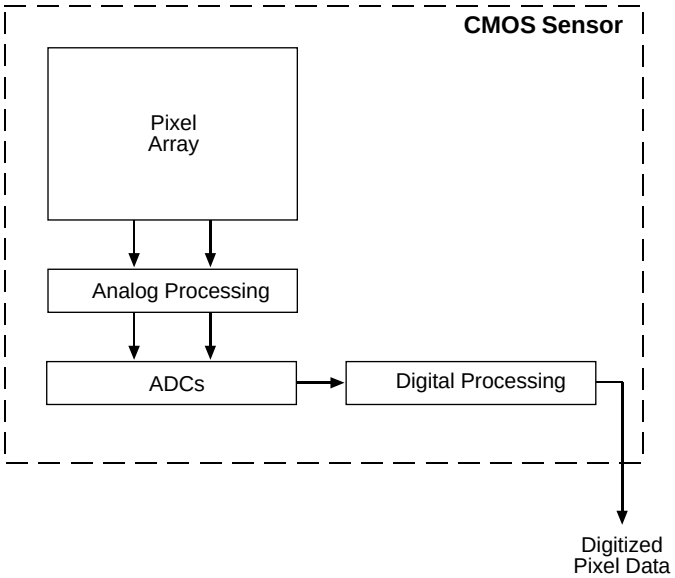


Fig. 33: CMOS Sensor Architecture

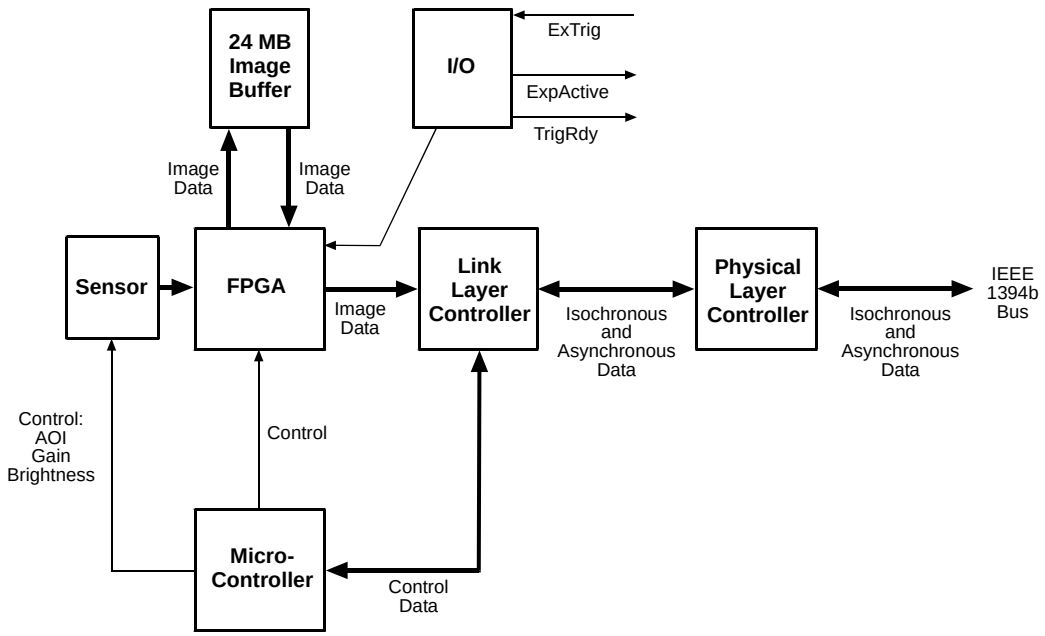


Fig. 34: Camera Block Diagram

4 Physical Interface

This section provides detailed information, such as pinouts and voltage requirements, for the physical interface on the camera. This information will be especially useful during your initial design-in process.

4.1 General Description of the Connections

The camera is interfaced to external circuity via connectors located on the back of the housing:

- an IEEE 1394b socket used to provide power and a bus connection to the camera.
- a 12-pin receptacle used to provide access to the camera's I/O ports.

There is also an LED indicator on the back.

The drawing below shows the location of the two connectors and the LED.

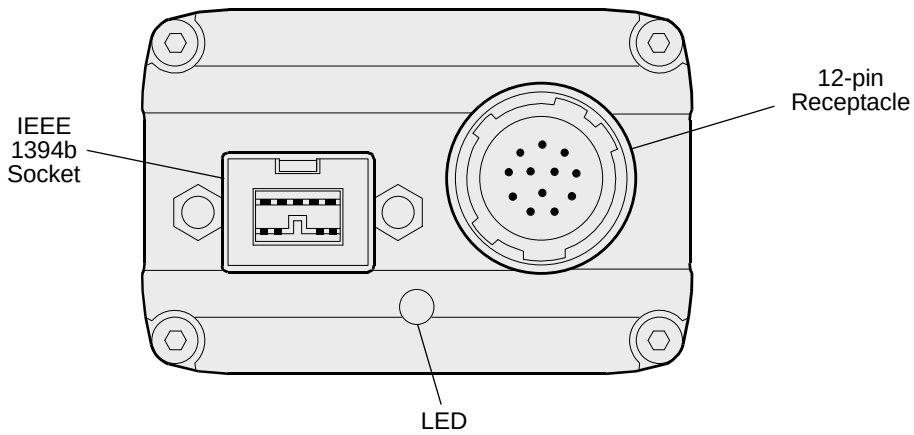


Fig. 35: Camera Connectors and LED

4.2 Connector Pin Assignments and Numbering

4.2.1 IEEE 1394b Socket Pin Assignments

The IEEE 1394b socket is used to supply power to the camera and to interface video data and control signals. The pin assignments for the socket are as shown in Table 6. Note that these are the standard pin assignments for IEEE 1394b sockets.

Pin	Signal	
1	TPB -	(twisted pair B minus)
2	TPB +	(twisted pair B plus)
3	TPA -	(twisted pair A minus)
4	TPA +	(twisted pair A plus)
5	TPA R	(twisted pair A ground)
6	VG	(power ground)
7	Not connected	
8	VP	(+8 to +36 VDC power)
9	TPB R	(twisted pair B ground)

Table 6: Pin Assignments for the IEEE 1394b Socket

Pin numbering for the IEEE 1394b socket is as shown in Section 4.2.3 on page 69.

4.2.2 12-pin Receptacle Pin Assignments

The 12 pin receptacle is used to access the two physical input ports and four physical output ports on the camera. The pin assignments for the receptacle are as shown in Table 7.

Pin	Designation
1	Not connected
2	Not connected
3	I/O Input 0
4	I/O Input 1
5	I/O Input Gnd
6	I/O Output 0
7	I/O Output 1
8	Not connected
9	Not connected
10	I/O Output VCC
11	I/O Output 2
12	I/O Output 3

Table 7: Pin Assignments for the 12-pin Receptacle

Pin numbering for the 12-pin receptacle is as shown in Section 4.2.3 on page 69.

4.2.3 Pin Numbering

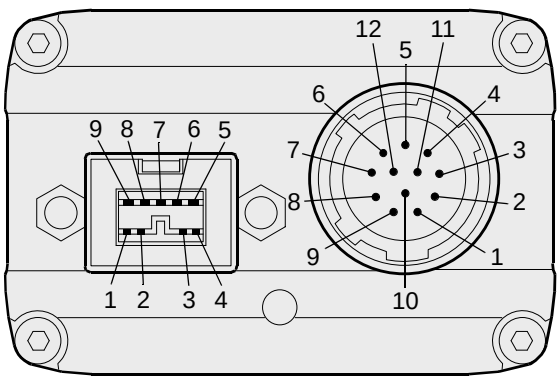


Fig. 36: Pin Numbering for the IEEE 1394b Socket and the 12-pin Receptacle

4.3 Connector Types

4.3.1 IEEE 1394b Connector

The 1394b socket on the camera is a standard, 9-pin IEEE 1394b bilingual socket.

The recommended mating connector is any standard, 9-pin IEEE 1394b plug.

4.3.2 12-pin Connector

The 12-pin connector on the camera is a Hirose micro receptacle (part number HR10A-10R-12P) or the equivalent.

The recommended mating connector is the Hirose micro plug (part number HR10A-10P-12S) or the equivalent.

4.4 Cabling Requirements

4.4.1 IEEE 1394b Cable

The maximum length of the IEEE 1394b cable used between the camera and the adapter in your PC or between the camera and a 1394b hub is 4.5 meters as specified in the IEEE 1394 standard.

Standard, 9-pin, shielded 1394b to 1394b cables should be used.

Note

The camera is backward compatible with IEEE 1394a devices. If you will be connecting the camera to an IEEE 1394a device, you must use a conversion cable. The cable should have a 9-pin IEEE 1394b plug on the end that connects to the camera and a 6-pin IEEE 1394a plug on the end that connects to the device.

4.4.2 Standard I/O Cable

Note

The standard I/O cable is intended for use if the camera is not connected to a PLC device. If the camera is connected to a PLC device, we strongly recommend using a PLC I/O cable rather than the standard I/O cable.

You can use a PLC I/O cable when the camera is not connected to a PLC device, if power for the I/O input is supplied with 24 VDC.

See the following section for more information about PLC I/O cables.

The end of the standard I/O cable that connects to the camera must be terminated with a Hirose micro plug (part number HR10A-10P-12S) or the equivalent. The cable must be wired as shown in Figure 37.

The maximum length of the standard I/O cable is at least 10 meters. The cable must be shielded and must be constructed with twisted pair wire. Use of twisted pair wire is essential to ensure that input signals are correctly received.

Close proximity to strong magnetic fields should be avoided.

The required 12-pin Hirose plug is available from Basler. Basler also offers a standard I/O cable assembly that is terminated with a 12-pin Hirose plug on one end and unterminated on the other. Contact your Basler sales representative to order connectors or I/O cables.

CAUTION

An Incorrect Plug Can Damage the 12-pin Connector

The plug on the cable that you attach to the camera's 12-pin connector must have 12 pins. Use of a smaller plug, such as one with 10 pins or 8 pins, can damage the pins in the camera's 12-pin connector.

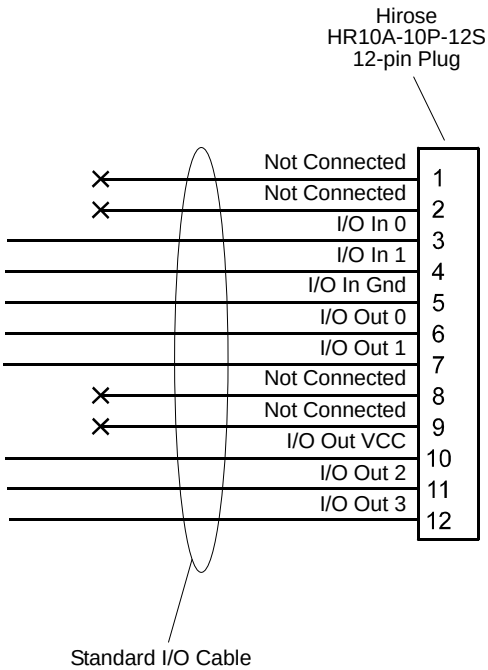


Fig. 37: Standard I/O Cable

4.4.3 PLC I/O Cable

As with the standard I/O cable described in the previous section, the PLC I/O cable is a single cable that connects to the camera's I/O lines.

The PLC I/O cable adjusts the voltage levels of PLC devices to the voltage levels required by the camera, and it protects the camera against negative voltage and reverse polarity.

The PLC I/O cable adjusts the voltage levels of PLC devices to the voltage levels required by the camera, and it protects the camera against negative voltage and reverse polarity.

Close proximity to strong magnetic fields should be avoided.

Note

We strongly recommend using a PLC I/O cable if the camera is connected to a PLC device.

You can use a PLC power and I/O cable when the camera is not connected to a PLC device, if power for the I/O input is supplied with 24 VDC.

Basler offers PLC I/O cables with 3 m and 10 m lengths. Each cable is terminated with a 12-pin Hirose plug (HR10A-10P-12S) on the end that connects to the camera. The other end is unterminated. Contact your Basler sales representative to order the cables.

For information about applicable voltage levels, see Section 4.7 on page 76.

4.5 Camera Power

Camera power must be supplied to the camera via the IEEE 1394b cable. Power consumption is as shown in the specification tables in Section 1 of this manual.

If your camera is connected to an IEEE 1394b adapter in a desktop computer, consult the instructions for the adapter and make sure that the adapter is properly configured to supply power to the camera.

If your camera is connected to a powered hub, consult the instructions for the hub and make sure that it is properly configured to supply power to the camera.

Many laptop computers have a connector for an IEEE 1394 device. In most cases, laptops **do not** supply power to the connected IEEE 1394 device. In this situation, you must use a powered hub between the laptop and the camera or you must install a PCMCIA IEEE 1394 adapter card that connects to an external power supply.

CAUTION

Incorrect Power Can Cause Damage

The polarity of the power on the camera's IEEE 1394b socket must be as shown in the pin assignment table. **Do not** reverse the power polarity. Reversing the polarity will damage the camera.

If the voltage supplied to the camera is greater than +36 VDC, damage to the camera can result. If the voltage is less than +8 VDC, the camera may operate erratically.

The following voltage requirements apply to the camera power (supplied via the IEEE 1394b cable):

Voltage	Significance
< +8 VDC	The camera may operate erratically.
+12 VDC	Recommended operating voltage; < 1 % ripple required.
+36 VDC	Absolute maximum; the camera may be damaged when the absolute maximum is exceeded.

Table 8: Voltage Requirements for the Camera Power

For more information about pin assignments, see Section 4.2 on page 68.

4.6 IEEE 1394b Device Information

The camera uses an IEEE1394b - 2002 compliant physical layer device that can transmit at speeds up to 800 Mbit/s (S800). The device is backward compatible with IEEE 1394a - 2000 devices.

Detailed spec sheets for IEEE 1394b - 2002 compliant physical layer devices of the type used in the camera are available at the Texas Instruments website: www.ti.com.

4.7 Input and Output Ports

4.7.1 Input Ports

4.7.1.1 Voltage Requirements

Note

Different voltage levels apply, depending on whether the standard I/O cable or a PLC I/O cable is used (see below)..

Voltage Levels When the Standard I/O Cable is Used

The following voltage requirements apply to the camera's I/O input (pins 3 and 4 of the 12-pin receptacle):

Voltage	Significance
+0 to +24 VDC	Recommended operating voltage.
+0 to +1.4 VDC	The voltage indicates a logical 0.
> +1.4 to +2.2 VDC	Region where the transition threshold occurs; the logical state is not defined in this region.
> +2.2 VDC	The voltage indicates a logical 1.
+30.0 VDC	Absolute maximum; the camera may be damaged when the absolute maximum is exceeded.

Table 9: Voltage Requirements for the I/O Input When Using the Standard Power and I/O Cable

Voltage Levels When a PLC I/O Cable is Used

The following voltage requirements apply to the input to the PLC I/O cable. The PLC I/O cable will adjust the voltages to the levels required at the camera's I/O input (see the previous table).

Voltage	Significance
+0 to +24 VDC	Recommended operating voltage.
+0 to +8.4 VDC	The voltage indicates a logical 0.
> +8.4 to +10.4 VDC	Region where the transition threshold occurs; the logical state is not defined in this region.
> +10.4 VDC	The voltage indicates a logical 1.
+30.0 VDC	Absolute maximum; the camera may be damaged when the absolute maximum is exceeded.

Table 10: Voltage Requirements for the I/O Input When Using a PLC I/O Cable

4.7.1.2 I/O Schematic

The camera is equipped with two physical input ports designated as Input Port 0 and Input Port 1. The input ports are accessed via the 12-pin receptacle on the back of the camera.

As shown in the I/O schematic, each input port is opto-isolated. For each port, an input voltage between +0 VDC and +1.4 VDC indicates a logical 0. An input voltage above +2.2 VDC indicates a logical 1. The region between +1.4 VDC and +2.2 VDC is a transition zone where the logical state is not defined. The absolute maximum input voltage is +30.0 VDC. The current draw for each input is between 5 and 15 mA.

Figure 38 shows an example of a typical circuit you can use to input a signal into the camera.

By default, Input Port 0 is assigned to receive an external hardware trigger (ExTrig) signal that can be used to control the start of exposure.

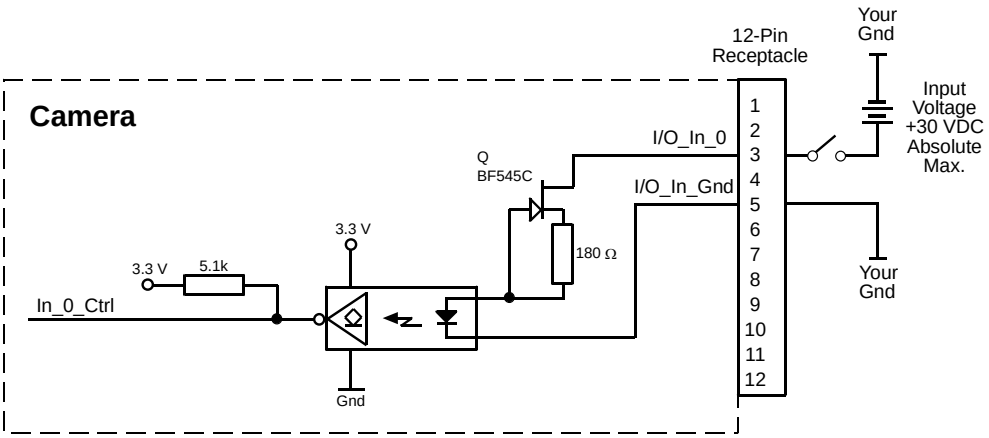


Fig. 38: Typical Input Circuit

The I/O schematic appears on page 82.

For more information about input port pin assignments and pin numbering, see Section 4.2 on page 68.

For more information about how to use an ExTrig signal to control exposure start, see Section 6.3.3 on page 94

For more information about assigning an input port to receive an ExTrig signal, see Section 6.3.2 on page 94.

4.7.2 Output Ports

4.7.2.1 Voltage Requirements

The following voltage requirements apply to the I/O output VCC (pin 10 of the 12-pin receptacle):

Voltage	Significance
< +3.3 VDC	The I/O output may operate erratically.
+3.3 to +24 VDC	Recommended operating voltage.
+30.0 VDC	Absolute maximum; the camera may be damaged when the absolute maximum is exceeded.

Table 11: Voltage Requirements for the I/O Output VCC

4.7.2.2 I/O Schematic

The camera is equipped with four physical output ports designated as Output Port 0, Output Port 1, Output Port 2, and Output Port 3. The output ports are accessed via the 12-pin receptacle on the back of the camera.

As shown in the I/O schematic, each output port is opto-isolated. The recommended operating voltage ranges from +3.3 VDC to +24 VDC. The absolute maximum voltage is +30.0 VDC. The maximum current allowed through an output circuit is 100 mA.

A conducting transistor means a logical one and a non-conducting transistor means a logical zero.

Figure 39 shows a typical circuit you can use to monitor an output port with a voltage signal. The circuit in Figure 39 is monitoring Output Port 0.

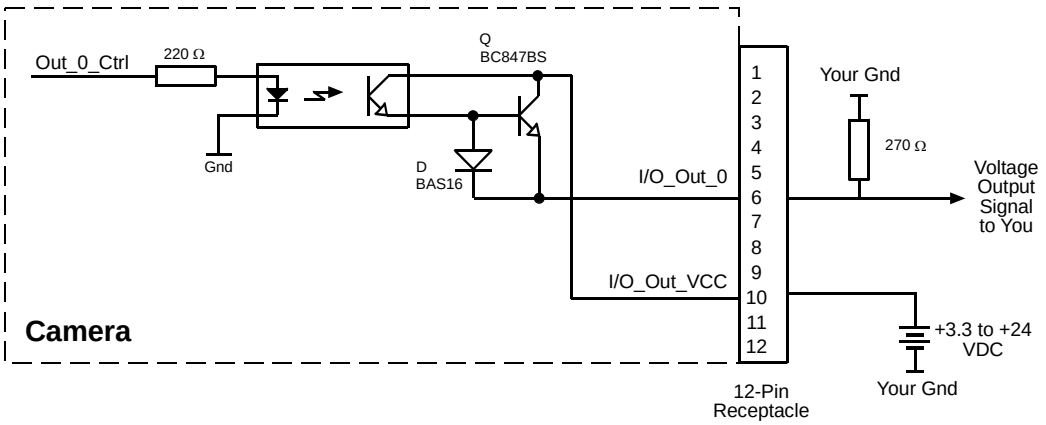


Fig. 39: Typical Voltage Output Circuit

Figure 40 shows a typical circuit you can use to monitor an output port with an LED or an opto-coupler. In this example, the voltage for the external circuit is +24 VDC. Current in the circuit is limited by an external resistor. The circuit in Figure 40 is monitoring Output Port 0.

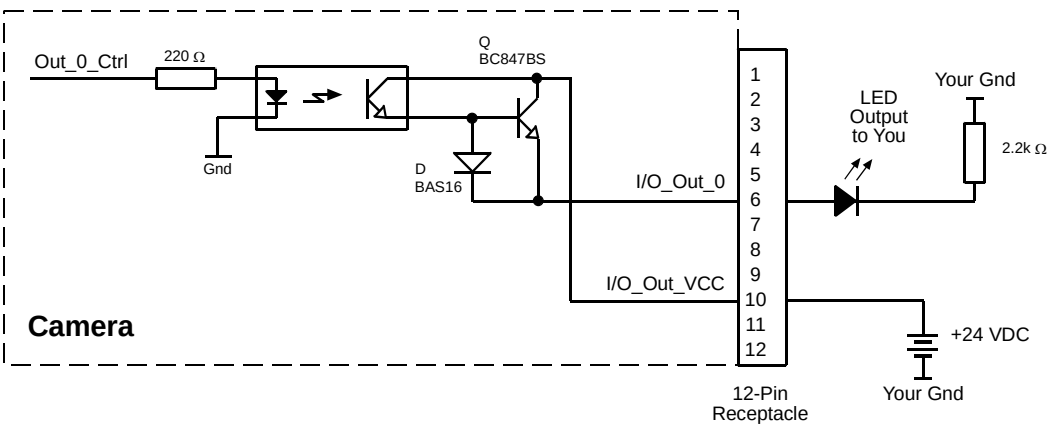


Fig. 40: Typical LED Output Signal at +24 VDC for the External Circuit (Example)

By default, the camera's integrate enabled (IntEn) signal is assigned to Output Port 0 . The integrate enabled signal indicates when exposure is taking place.

By default, the camera's trigger ready (TrigRdy) signal is assigned to Output Port 1. The trigger ready signal goes high to indicate the earliest point at which exposure start for the next frame can be triggered.

The assignment of camera output signals to physical output ports can be changed by the user.

Note

At power on, the output ports will go high briefly while the FPGA is configured. Once FPGA configuration is complete, the output ports reset to low.

The I/O schematic appears on page 82.

For more information about output port pin assignments and pin numbering, see Section 4.2 on page 68.

For more information about the integrate enabled signal, see Section 6.8 on page 108.

For more information about the trigger ready signal, see Section 6.7 on page 103.

For more information about assigning camera output signals to physical output ports, see Section 9.6.7 on page 216.

4.7.2.3 Output Port Response Times

Response times for the output ports on the camera are as shown below.

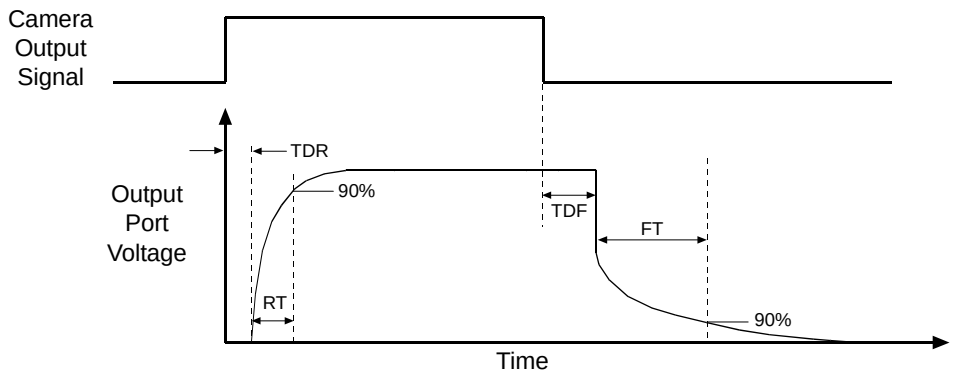


Fig. 41: Output Port Response Times

Time Delay Rise (TDR) = 1.5 µs

Rise Time (RT) = 1.3 - 5.0 µs

Time Delay Fall (TDF) = 1 - 20 µs

Fall Time (FT) = 1 - 5 µs

Note

The response times for the output ports on your camera will fall into the ranges specified above. The exact response time for your specific application will depend on the external resistor and the applied voltage you use.

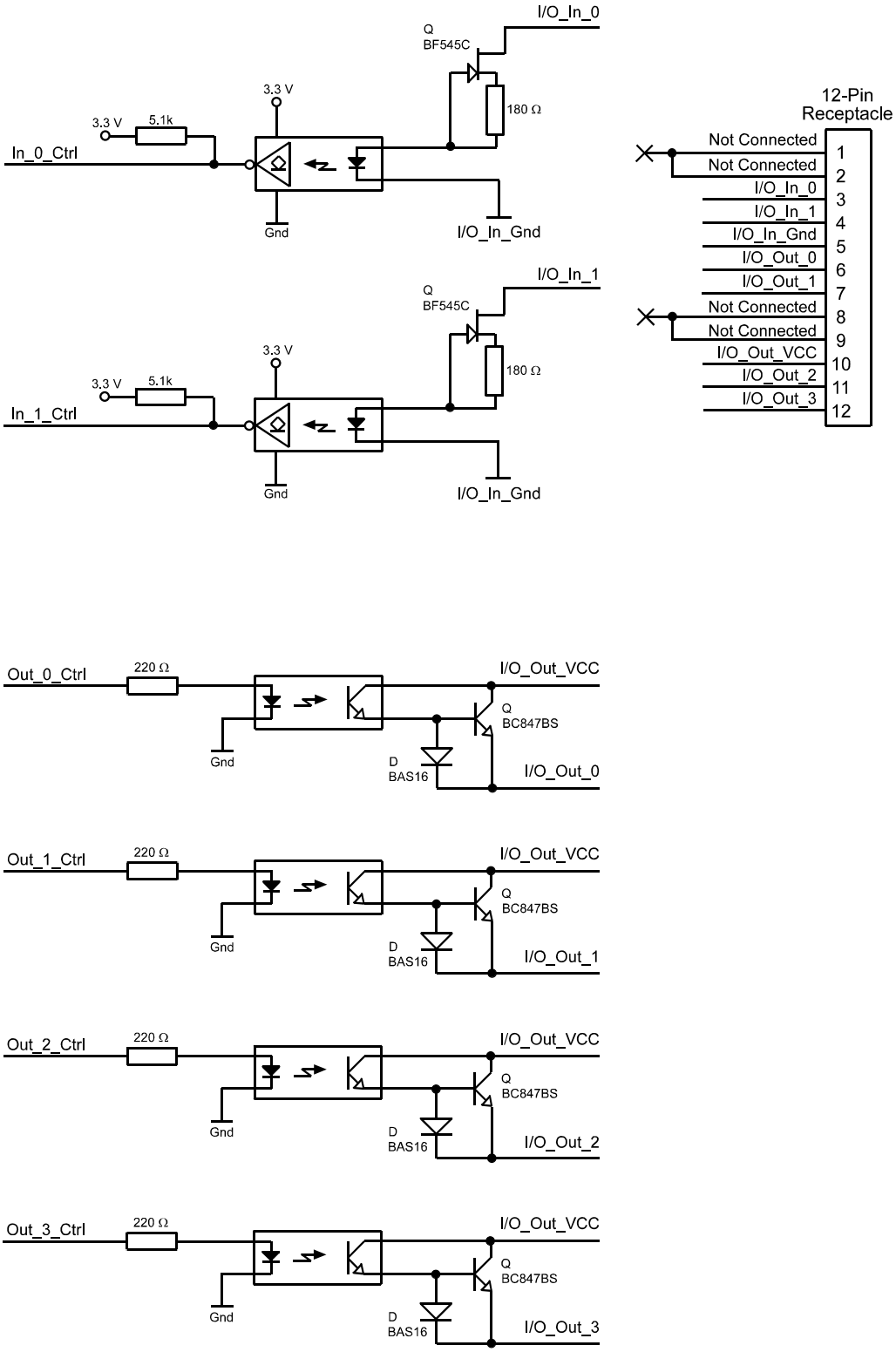


Fig. 42: I/O Port Schematic

5 Tools for Configuring the Camera

This section explains the software interface options available for configuring your camera. Three options are available, the Basler BCAM API, the Basler BCAM Viewer, and APIs included with other DCAM complaint drivers.

5.1 The BCAM Driver API

The Basler BCAM 1394 Driver is available for Basler IEEE 1394b cameras. The Basler BCAM 1394 Driver/Software Development Kit (SDK) includes an API that allows a C++ programmer to easily integrate camera configuration and operating functions into your system control software.

The SDK comes with comprehensive documentation including code samples. For more information, visit the Basler web site at: www.baslerweb.com.

The cameras include a set of vendor unique "smart features." Access to the functionality of the smart features is not available through the BCAM driver. Instead, the smart features are accessed via Basler’s Smart Features Framework (SFF) software. More information about the SFF software is available at the Basler web site.

For more information about smart features and the smart features framework, see Section 9 on page 169.

5.2 The BCAM Viewer

The Basler BCAM Viewer is included as part of the Basler BCAM Software Development Kit (SDK). The BCAM Viewer provides access to all of the camera’s settings via a GUI based interface. The viewer also lets you acquire images and display them. Using The BCAM Viewer software is a very convenient way to get your camera up and running quickly when you are doing your initial camera evaluation or doing a camera design-in for a new project.

The BCAM Viewer is also available as part of a freely available run-time package that does not include the complete SDK.

For more information about using the BCAM Viewer, see Section 2.4 on page 53.

5.3 Other DCAM Compliant Drivers

Your camera can be configured by setting status and control registers as described in the “1394-Based Digital Camera Specification” issued by the 1394 Trade Association. The specification is commonly referred to as the “DCAM standard” or the “IIDC” standard.” It is available at the 1394 Trade Association’s web site: www.1394ta.org.

Basler IEEE 1394b cameras are compliant with the DCAM standard and except where noted, all registers conform to version 1.31 of the standard.

DCAM compliant drivers made by other suppliers are commercially available and these drivers include APIs that can be used to access the basic functionality of your camera.

For more information about the register structure implemented in the camera, see Section 11 on page 235.

6 Exposure Control

This section provides detailed information about controlling image exposure. You will find details about setting the exposure time for each captured image and about how the camera's maximum allowed frame capture rate can vary depending on the current camera settings.

6.1 Controlling Exposure Start with "Shot" Commands and No Triggering

Exposure start can be controlled by simply sending "shot" commands directly to the camera via the 1394 bus. In this case, a software trigger or an external hardware trigger (ExTrig) signal is not used. When exposure start is controlled with shot commands via the 1394 bus, two modes of operation are available: one-shot and continuous-shot.

6.1.1 One-Shot Operation

In one-shot operation, the camera exposes and transmits a single image. Exposure begins when the One Shot field of the camera's One Shot/Multi Shot control register is set to 1. Exposure time is determined by the camera's shutter settings.

The One Shot field is self cleared to 0 after transmission of the image data.

When using the camera's one-shot capability, you must not begin capturing a new image until the previously captured image has been completely transmitted to the host PC.

For more information about the One Shot/Multi Shot control register, see page 263.

For more information about the shutter settings, see Section 6.4 on page 98.

The Basler BCAM 1394 Driver includes method calls for using the camera's one-shot functionality. For more information, see the online documentation delivered with the BCAM Driver.

6.1.2 Continuous-Shot Operation (Free-run)

In continuous-shot operation, the camera continuously exposes and transmits images. The exposure of the first image begins when the Continuous Shot field of the ISO En/Continuous Shot control register is set to 1. The exposure time for each image is determined by the camera's shutter settings. The start of exposure on the second and subsequent images is automatically controlled by the camera. (This is commonly referred to as "free-run" operation.)

Image exposure and transmission stop when the Continuous Shot field of the ISO En/Continuous Shot control register is set to 0.

If the camera is set for video format 0, 1, or 2, the rate at which images will be captured and transmitted is determined by the setting in the Frame Rate field of the Current Video Frame Rate/ Revision control register.

If the camera is set for video format 7, the rate at which images will be captured and transmitted is determined by the settings in the Frame Rate control register:

- If the value in the On/Off field is set to 0 (manual control off), the camera will operate at the maximum frame rate allowed with the current camera settings.
- If the value in the On/Off field is set to 1 (manual control on) and the value in the Frame Rate field is less than the maximum frame rate allowed, the camera will operate at the frame rate specified by the value in the Frame Rate field.
- If the value in the On/Off field is set to 1 (manual control on) and the value in the Frame Rate field is greater than the maximum frame rate allowed, the camera will operate at the maximum allowed rate.

For more information about the shutter settings, see Section 6.4 on page 98.

For more information about the ISO En/Continuous Shot control register, see page 263.

For more information about the Current Video Frame Rate/Revision control register, see page 261.

For more information about the Frame Rate control register, see page 272.

For more information about the maximum allowed frame rate in format 7, see Section 7.2.2 on page 118.

The Basler BCAM 1394 Driver includes method calls for using the camera's continuous-shot functionality. For more information, see the online documentation delivered with the BCAM Driver. (The driver does not include a method call to access the Frame Rate control register. As a work around, you can use the Basler Smart Features Framework software to directly read from or write to the register. For more information about the Smart Features Framework software, see Section 9.2 on page 169.)

Note

The explanations of exposure control in Section 6.1.1 and Section 6.1.2 are included to give you a basic insight into the interactions of the camera's registers. Typically, IEEE 1394 cameras are used with a driver that includes an interface for parameterizing and operating the camera. The Basler BCAM 1394 Driver, for example, has both a simple Windows® interface and a programmer's API for parameterizing and operating the camera.

6.2 Controlling Exposure with a Software Trigger

Exposure start can be controlled by sending a software trigger command to the camera via the 1394 bus. The Trigger Mode control register is used to enable the ability to start image exposure with a software trigger. The Software Trigger control register is used to set the software trigger.

If you are triggering the camera with a software trigger, only the programmable exposure mode is available. In programmable mode, exposure starts when the Trigger field of the Software Trigger control register is set to 1. The length of the exposure is determined by the camera's shutter time setting. The Trigger field will self clear when it is safe to begin exposure of another image. Figure 43 illustrates programmable exposure with a software trigger.

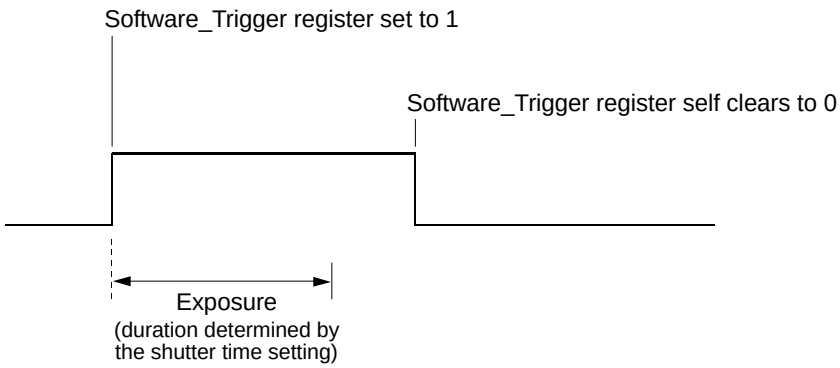


Fig. 43: Programmable Exposure with a Software Trigger

6.2.1 Enabling the Software Trigger Feature

To enable the software trigger feature:

- Set the On/Off field of the Trigger Mode control register to 1 to enable triggering.
- Set the Trigger Source field of the Trigger Mode control register to 7 to select a software trigger.
- Set the Trigger Mode field of the Trigger Mode control register to 0 to select the programmable exposure mode.

For more information about the Trigger Mode Control register, see page 271.

The Basler BCAM 1394 Driver includes method calls to enable triggering. For more information, see the online documentation delivered with the BCAM Driver.
(The driver does not include method call to access the Trigger Source field of the Trigger Mode control register. As a work around, you can use the Basler Smart Features Framework software to directly read from or write to the register. For more information about the Smart Features Framework software, see Section 9.2 on page 169.)

6.2.2 Using the Software Trigger Feature

Software Trigger / One-shot Operation

In Software Trigger/One-shot operation, a “one-shot command” is used to prepare the camera to capture a single image. Exposure will begin when the Trigger field of the Software Trigger control register is set to 1. To use this operating method, follow this sequence:

1. Use the shutter time setting to set your desired exposure time.
2. Set the One Shot field of the One Shot/Multi Shot control register to 1. This prepares the camera to capture a single image.
3. Set the Trigger field of the Software Trigger control register to 1. Exposure will begin.
4. Exposure will continue for the length of time you specified in step 1.
5. At the end of the specified exposure time, readout and transmission of the captured image will take place.
6. The Trigger field will self-clear to 0 after the image has been transmitted.
7. To capture another image, wait until the captured image has been completely received by the host PC and then return to step 2.

For more information about the shutter time setting, see Section 6.4 on page 98.

For more information about the One Shot/Multi Shot control register, see page 263.

The Basler BCAM 1394 Driver includes method calls for using the camera’s one-shot functionality. For more information, see the online documentation delivered with the BCAM Driver.
(The driver does not include method call to access the Software Trigger control register. As a work around, you can use the Basler Smart Features Framework software to directly read from or write to the register. For more information about the Smart Features Framework software, see Section 9.2 on page 169.)

Software Trigger / Continuous-shot Operation

In Software Trigger/Continuous-shot operation, a “continuous-shot command” is used to prepare the camera to capture multiple images. With this method of operation, exposure will begin each time the Trigger field of the Software Trigger control register is set to 1. To use this operating method, follow this sequence:

1. Use the shutter time setting to set your desired exposure time.
2. Set the Continuous Shot field of the ISO En/Continuous Shot control register to 1. This prepares the camera to react to software trigger signals.
3. Check the state of the Trigger field of the Software Trigger control register:
   a. If the field is set to 0, you can set the field to 1 when desired.
   b. If the field is set to 1, wait until the field clears to 0 and then set it to 1 when desired.
4. Set the Trigger field to 1. Exposure will begin.
5. Exposure will continue for the length of time you specified in step 1.

6. At the end of the specified exposure time, readout and transmission of the captured image will take place.
7. The Trigger field will self-clear to 0.
8. Repeat steps 3 and 4 each time you want to begin exposure and capture an image.

To disable continuous-shot operation, set the Continuous Shot field in the ISO En/Continuous Shot control register to 0.

If the camera is set for video format 0, 1, or 2, the rate at which the Trigger field self-clears to 0 will be determined by the setting in the Frame Rate field of the Current Video Frame Rate/Revision control register.

If the camera is set for video format 7, the rate at which the Trigger field self-clears to 0 will be determined by the setting in the Frame Rate field of the Frame Rate control register:

- If the value in the On/Off field is set to 0 (manual control off), the camera will operate at the maximum frame rate allowed with the current camera settings.
- If the value in the On/Off field is set to 1 (manual control on) and the value in the Frame Rate field is less than the maximum frame rate allowed, the camera will operate at the frame rate specified by the value in the Frame Rate field.
- If the value in the On/Off field is set to 1 (manual control on) and the value in the Frame Rate field is greater than the maximum frame rate allowed, the camera will operate at the maximum allowed rate.

For more information about the shutter time setting, see Section 6.4 on page 98.

For more information about the ISO En/Continuous Shot control register, see page 263.

The Basler BCAM 1394 Driver includes method calls for using the camera's continuous-shot functionality. For more information, see the online documentation delivered with the BCAM Driver. (The driver does not include method call to access the Software Trigger or the Frame Rate control registers. As a work around, you can use the Basler Smart Features Framework software to directly read from or write to the registers. For more information about the Smart Features Framework software, see Section 9.2 on page 169.)

Note

The explanation of exposure control in Section 6.2.2 is included to give you a basic insight into the interactions of the camera's registers. Typically, IEEE 1394 cameras are used with a driver that includes an interface for parameterizing and operating the camera. The Basler BCAM 1394 Driver, for example, has both a simple Windows® interface and a programmer's API for parameterizing and operating the camera.

6.2.3 Why Use the Software Trigger

At first glance, using the software trigger feature to start image exposure appears to be equivalent to just issuing a simple one-shot command without a software trigger. The difference lies in the way the camera reacts to each method. With a simple one-shot command, there will be some delay between the One Shot field of the One Shot/Multi Shot control register being set to 1 and the actual start of exposure. This delay is required so that the camera can be properly set up to react to the receipt of the one-shot command. With the software trigger method, there is no delay between the Trigger field being set to 1 and the start of exposure. Exposure begins immediately when the field value is set. So the advantage of the software trigger feature is that it gives you more precise control of exposure start.

6.3 Controlling Exposure with a Hardware Trigger

You can configure the camera so that an external hardware trigger (ExTrig) signal applied to one of the input ports will control image capture. A rising edge or a falling edge of the ExTrig signal can be used to trigger exposure start.

The ExTrig signal can be periodic or non-periodic. When the camera is operating under control of an ExTrig signal, the period of the ExTrig signal will determine the rate at which the camera is capturing images:

$$\frac{1}{\text{ExTrig period in seconds}} = \text{Frame Capture Rate}$$

For example, if you are operating a camera with an ExTrig signal period of 20 ms (0.020 s):

$$\frac{1}{0.020\ \text{s}} = 50\ \text{fps}$$

So in this case, the frame capture rate is 50 fps.

The minimum high time for a rising edge trigger (or low time for a falling edge trigger) is 100 nanoseconds.

When you are triggering image capture with an ExTrig signal, you must not capture images at a rate that exceeds the maximum allowed for the current camera settings.

6.3.1 Exposure Modes

If you are triggering image capture with an ExTrig signal, two exposure modes are available, "programmable" and "level controlled."

Programmable Mode

When programmable mode is selected, the exposure time for each image is determined by the camera's shutter time setting. If the camera is set for rising edge activation, the exposure time starts when the ExTrig signal rises. If the camera is set for falling edge activation, the exposure time starts when the ExTrig signal falls. Figure 44 illustrates programmable exposure with the camera set for rising edge activation.

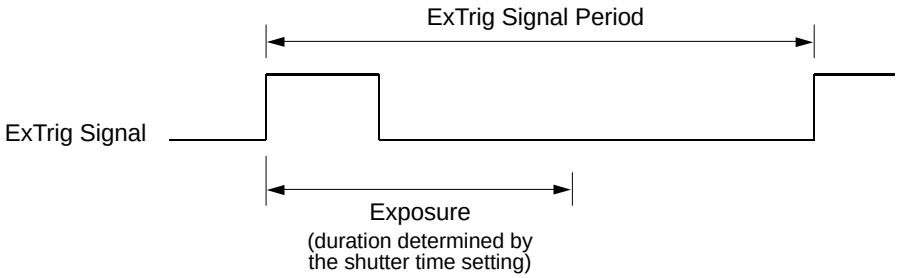


Fig. 44: Programmable Exposure with Rising Edge Activation

Level Controlled Exposure Mode

When level controlled exposure mode is selected, the length of the exposure will be directly controlled by the ExTrig signal. If the camera is set for rising edge activation, the exposure time begins when the ExTrig signal rises and continues until the ExTrig signal falls. If the camera is set for falling edge activation, the exposure time begins when the ExTrig signal falls and continues until the ExTrig signal rises. Figure 45 illustrates level controlled exposure with the camera set for rising edge activation.

Level controlled exposure is especially useful if you intend to vary the length of the exposure time for each captured image.

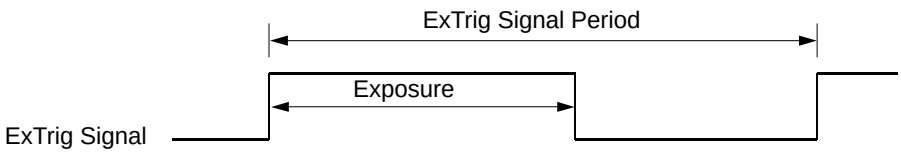


Fig. 45: Level Controlled Exposure with Rising Edge Activation

Note

The level controlled exposure mode **is not** available on scA750-60 cameras. The level controlled exposure mode is available on all other camera models.

When you operate the camera in level controlled exposure mode, you must use the camera's shutter time setting to set a minimum exposure time. In level controlled operation, the exposure time specified by the shutter time setting will be used by the camera to operate its trigger ready signal.

You should adjust the shutter time setting to represent the shortest exposure time you intend to use. For example, assume that you will be using level controlled exposure and that you intend to use the ExTrig signal to vary the exposure time in a range from 3000 µs to 5500 µs. In this case you would use the shutter time setting to set the minimum exposure time to 3000 µs.

If you are using the level controlled exposure mode and the camera is operating with overlapped exposures, there is something you must keep in mind. If the action of the ExSync signal would end the current exposure while readout of the previously captured image is still taking place, the camera will automatically continue the exposure until readout of the previous frame is complete. This situation is illustrated Figure 44 for rising edge activation. On the first cycle of the ExTrig signal shown in the figure, the signal rises and falls while readout is taking place. Normally you would expect exposure to take place only when the ExTrig signal is high. But since the signal falls while the previous frame is still reading out, the camera automatically extends exposure until the readout is complete. On the second cycle of the ExTrig signal shown in the figure, the signal rises during previous frame readout, but falls after the readout is complete. This is a normal situation and exposure would be determined by the high time of the ExTrig signal as you would expect.

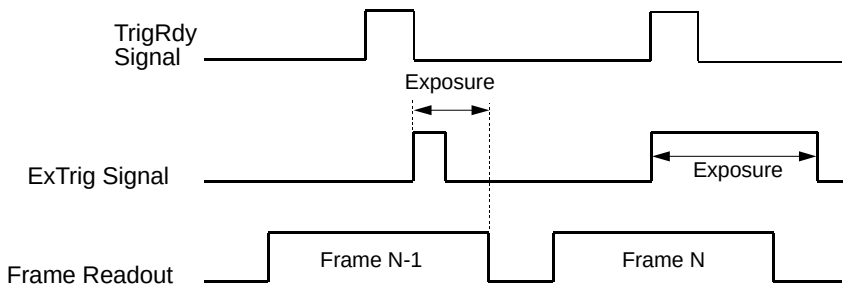


Fig. 46: Overlapped Level Controlled Exposure

For more information about the shutter time setting, see Section 6.4 on page 98.

For more information about overlapped exposure, see Section 6.5 on page 100.

For more detailed information about using the level controlled exposure mode with overlapped exposure, refer to the application notes called "Using a Specific External Trigger Signal with Overlapped Exposure" (AW000565xx000). The application notes are available in the downloads section of the Basler website: www.baslerweb.com.

6.3.2 Setting the Camera for Hardware Triggering

To set the camera for triggering with an external hardware trigger (ExTrig) signal:

- Set the On/Off field of the Trigger Mode control register to 1 to enable triggering.
- Set the Trigger Polarity field of the Trigger Mode control register to 0 to select falling edge triggering or 1 to select rising edge triggering.
- Set the Trigger Mode field of the Trigger Mode control register to 0 to select the programmable exposure mode or 1 to select the level controlled exposure mode.
- Set the Trigger Source field in the Trigger Mode control register to select which one of the two physical input ports on the camera will be used to receive the external trigger signal:
  - Set the Trigger Source field to 0 to select physical input port 0 to receive the ExTrig signal.
  - Set the Trigger Source field to 1 to select physical input port 1 to receive the ExTrig signal.

The default setting is for physical input port 0 to receive the ExTrig signal.

For more information about the Trigger Mode control register, see page 271.

The Basler BCAM 1394 Driver includes method calls to enable triggering and to set the trigger polarity. For more information, see the online documentation delivered with the BCAM Driver. (The driver does not include method call to access the Trigger Source field of the Trigger Mode control register. As a work around, you can use the Basler Smart Features Framework software to directly read from or write to the register. For more information about the Smart Features Framework software, see Section 9.2 on page 169.)

6.3.3 Using Hardware Triggering

The external hardware trigger (ExTrig) signal must be used in combination with a one-shot or a continuous-shot command. If more precise control of exposure start time is desired when you are using continuous-shot, you must also monitor the camera's Trigger Ready (TrigRdy) output signal and you must base the timing of the ExTrig signal on the state of the Trigger Ready signal.

The following descriptions assume that the ExTrig signal is set for rising edge triggering and the programmable exposure mode.

For more information about the Trigger Ready signal, see Section 6.7 on page 103.

ExTrig / One-shot Operation

In ExTrig/One-shot operation, a "one-shot" Command is used to prepare the camera to capture a single image. When the ExTrig signal rises, exposure will begin. To use this operating method, follow this sequence:

1. Use the shutter time setting to set your desired exposure time.
2. Set the One Shot field of the One Shot/Multi Shot control register to 1. This prepares the camera to capture a single image.

3. When desired, transition the ExTrig signal from low to high.
4. When ExTrig rises, exposure will begin. Exposure will continue for the length of time you specified in step 1.
5. At the end of the specified exposure time, readout and transmission of the captured image will take place.
6. The One Shot field of the One Shot/Multi Shot control register will self-clear to 0 after the image has been transmitted.
7. To capture another image, wait until the captured image has been completely received by the host PC and then return to step 2.

For more information about the shutter time setting, see Section 6.4 on page 98.

For more information about the One Shot/Multi Shot control register, see page 263.

The Basler BCAM 1394 Driver includes method calls for using the camera's one-shot functionality. For more information, see the online documentation delivered with the BCAM Driver.

ExTrig / Continuous Shot Operation

In ExTrig/Continuous-shot operation, a “continuous-shot” command is used to prepare the camera to capture multiple images. With this method of operation, exposure will begin on each rising edge of the ExTrig signal. To use this operating method, follow this sequence:

1. Use the shutter time setting to set your desired exposure time.
2. Set the Continuous Shot field of the ISO En/Continuous Shot control register to 1. This prepares the camera to react to ExTrig signals.
3. Check the state of the trigger ready (TrigRdy) signal:
   a. If TrigRdy is high, you can toggle ExTrig when desired.
   b. If TrigRdy is low, wait until TrigRdy goes high and then toggle ExTrig when desired.
4. When ExTrig rises, exposure will begin. Exposure will continue for the length of time you specified in step 1.
5. At the end of the specified exposure time, readout and transmission of the captured image will take place.
6. Repeat steps 3 and 4 each time you want to begin an exposure.
7. To disable continuous-shot operation, set the Continuous Shot field in the ISO En/Continuous Shot control register to 0.

If the camera is set for video format 0, 1, or 2, the rate at which the trigger ready signal will rise will be determined by the setting in the Frame Rate field of the Current Video Frame Rate/Revision control register.

If the camera is set for video format 7, the rate at which the trigger ready signal will rise will be determined by the setting in the Frame Rate field of the Frame Rate control register:

- If the value in the On/Off field is set to 0 (manual control off), the camera will operate at the maximum frame rate allowed with the current camera settings.
- If the value in the On/Off field is set to 1 (manual control on) and the value in the Frame Rate field is less than the maximum frame rate allowed, the camera will operate at the frame rate specified by the value in the Frame Rate field.
- If the value in the On/Off field is set to 1 (manual control on) and the value in the Frame Rate field is greater than the maximum frame rate allowed, the camera will operate at the maximum allowed rate.

For more information about the shutter time setting, see Section 6.4 on page 98.

For more information about the Trigger Ready signal, Section 6.7 on page 103.

The Basler BCAM 1394 Driver includes method calls for using the camera’s continuous-shot functionality. For more information, see the online documentation delivered with the BCAM Driver. (The driver does not include method call to access the Frame Rate control register. As a work around, you can use the Basler Smart Features Framework software to directly read from or write to the register. For more information about the Smart Features Framework software, see Section 9.2 on page 169.)

Note

The explanation of exposure control in Section 6.3.3 is included to give you a basic insight into the interactions of the camera's registers. Typically, IEEE 1394 cameras are used with a driver that includes an interface for parameterizing and operating the camera. The Basler BCAM 1394 Driver, for example, has both a simple Windows® interface and a programmer's API for parameterizing and operating the camera.

6.4 Setting the Shutter Time

When the camera is set to use a software trigger or is set to use a hardware trigger and the programmable mode, the camera's shutter time setting will determine the exposure time for the captured images. The shutter time setting is actually a combination of two values. The first is the value in the Value field of the Shutter control register. The second is the Shutter Time Base. The shutter time setting is the product of these two values:

Shutter Time Setting = (Value Field of the Shutter Control Register) x (Shutter Time Base)

By default, the shutter time base is set to 0.000020 s (20 µs) on all camera models except the scA750-60. On scA750-60 cameras, the default shutter time base is 0.000031 s (31 µs).

The shutter time setting is normally adjusted by changing the value in the Value field of the Shutter control register. The value field can range from 1 to 4095. So if the value field was set to 100 on an scA640-70 camera, for example, the shutter time will be 100 x 0.000020 s or 0.002 s (2000 µs).

The shutter time must not be set below a minimum specified value. The minimum shutter time setting varies by camera model as shown in Table 12.

The maximum shutter time that can be set also varies by camera model as shown in Table 12.

Camera Model	Minimum Allowed Shutter Time	Maximum Possible Shutter Time
scA640-70fm/fc	80 µs	10000000 µs
scA640-74fm/fc	80 µs	10000000 µs
scA750-60fm/fc	124 µs	126976 µs
scA780-54fm/fc	80 µs	10000000 µs
scA1000-20fm/fc	120 µs	10000000 µs
scA1000-30fm/fc	100 µs	10000000 µs
scA1300-32fm/fc	60 µs	10000000 µs
scA1390-17fm/fc	100 µs	10000000 µs
scA1400-17fm/fc	100 µs	10000000 µs
scA1400-30fm/fc	100 µs	10000000 µs
scA1600-14fm/fc	100 µs	10000000 µs

Table 12: Minimum Allowed Exposure Time and Maximum Possible Exposure Time

As mentioned above, the shutter time base is normally fixed and the shutter time setting is normally adjusted by changing the value field. However, if you require a shutter time setting that is shorter or longer than what you can achieve by changing the shutter value field alone, the shutter time base can also be changed. The Shutter Time Base smart feature can be used to change the shutter time base.

For more information about the Shutter control register, see page 269.

For more information about the Shutter Time Base smart feature, and on settings for obtaining the maximum possible exposure time, see Section 9.6.8 on page 219.

The Basler BCAM 1394 Driver includes a method call for setting the shutter. For more information, see the online documentation delivered with the BCAM Driver.

6.5 Overlapping Exposure and Sensor Readout (All Models Except scA750-60)

Note

The information in this section applies to all camera models except the scA750-60 fm/fc. For information about scA750-60 cameras, see Section 6.6 on page 102.

The image capture process on the camera includes two distinct parts. The first part is the exposure of the pixels in the imaging sensor. Once exposure is complete, the second part of the process – readout of the pixel values from the sensor – takes place.

In regard to this image capture process, there are two ways to operate the camera when you are using triggering to control image capture - with “non-overlapped” exposure and with “overlapped” exposure. In the non-overlapped mode of operation, each time an image is captured, the camera completes the entire exposure/readout process before capture of the next image is started. This situation is illustrated in Figure 47.

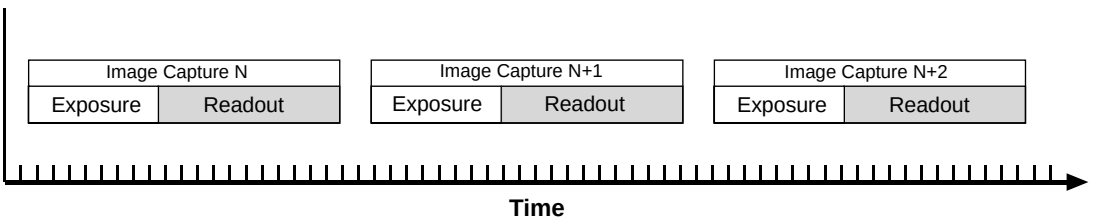


Fig. 47: Non-overlapped Readout and Exposure

While operating in a non-overlapped fashion is perfectly normal and is appropriate for many situations, it is not the most efficient way to operate the camera in terms of maximum frame rate. On this camera, however, it is allowable to begin exposing a new image while a previously captured image is being read out. This situation is illustrated in Figure 48 and is known as operating the camera with “overlapped” exposure.

As you can see, running the camera with readout and exposure overlapped can allow higher frame rates because the camera is performing two processes at once.

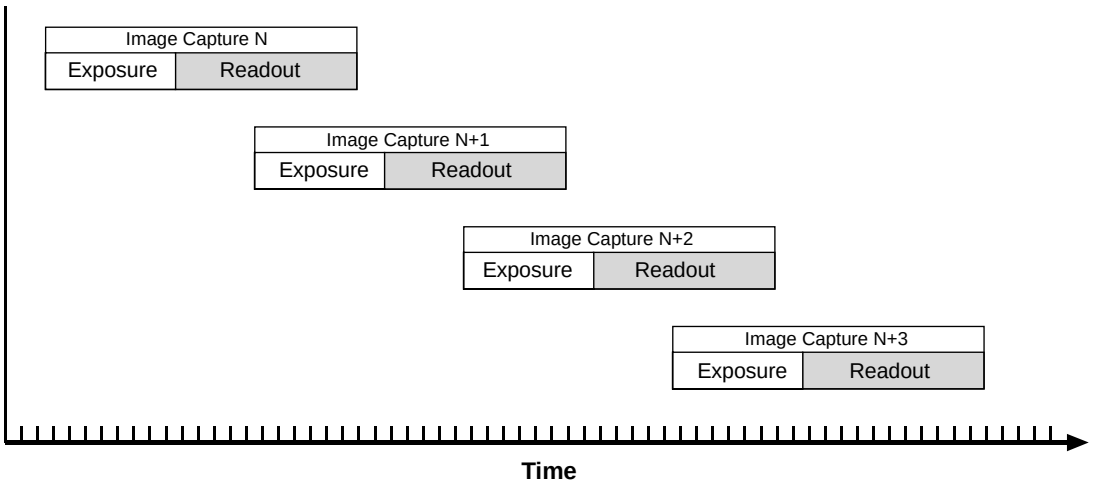


Fig. 48: Overlapped Readout and Exposure

Determining whether your camera is operating with overlapped or non-overlapped exposures is not a matter of issuing a command or switching a setting on or off. Rather the way that you operate the camera will determine whether the exposures are overlapped or not overlapped. If we define the “frame period” as the time from the start of exposure for one image capture to the start of exposure for the next image capture, then:

- Exposure will overlap when: Frame Period ≤ Exposure Time + Readout Time
- Exposure will not overlap when: Frame Period > Exposure Time + Readout Time

You can calculate the readout time for a captured image by using the formula on page 110.

6.5.1 Guidelines for Overlapped Operation

If you will be operating the camera with overlapped exposures, there are two **very important** guidelines to keep in mind:

- You must not begin the exposure time for a new image capture while the exposure time of the previously captured image is in progress.
- You must not end the exposure time of the current image capture until readout of the previously captured image is complete.

If either of these guidelines is violated, the camera will produce unacceptable images or may stop capturing images and require a reset.

When you are operating a camera with overlapped exposure and using a hardware trigger signal to trigger image capture, you could use the camera’s shutter setting and the timing formulas to calculate when it is safe to begin each new capture. However, there is a much more convenient way to know when it safe to begin each capture. The camera supplies a “trigger ready” signal that is specifically designed to let you trigger overlapped exposure safely and efficiently.

For more information on using the Trigger Ready signal with all camera models except the scA750-60 fm/fc, see Section 6.7 on page 103.

For more detailed guidelines about using an external trigger signal with the level controlled exposure mode and overlapped exposure, refer to the application notes called "Using a Specific External Trigger Signal with Overlapped Exposure" (AW000565xx000). The application notes are available in the downloads section of the Basler website: www.baslerweb.com.

6.6 Exposure Must Not Overlap Sensor Readout (scA750-60 Only)

Note

The information in this section only applies to scA750-60 fm/fc cameras. For information about the other camera models, see Section 6.5 on page 100.

The image capture process on the camera includes two distinct parts. The first part is the exposure of the pixels in the imaging sensor. Once exposure is complete, the second part of the process – readout of the pixel values from the sensor – takes place.

On these cameras, exposure for a new capture must not begin until readout of the previously captured image is complete. This situation is illustrated in Figure 47.

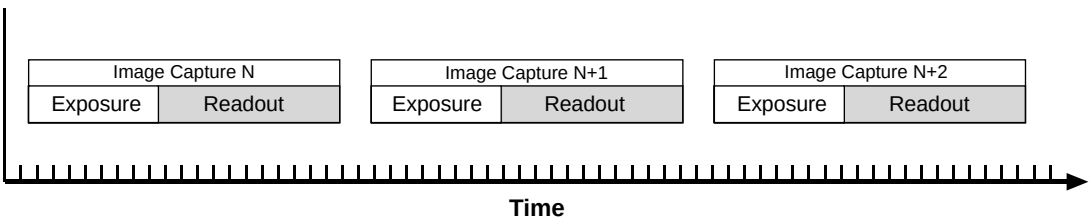


Fig. 49: Non-overlapped Readout and Exposure

A result of this characteristic is that the exposure time setting on the camera will have a direct effect on the camera's maximum allowed frame rate. At longer exposure times, the maximum allowed frame rate will be lower.

When you are operating a camera and using a hardware trigger to trigger image capture, you could use the camera's shutter settings and the timing formulas to calculate when it is safe to begin each new capture. However, there is a more convenient way to know when it safe to begin each capture. The camera supplies a "trigger ready" signal that is specifically designed to let you trigger captures safely and efficiently.

For more information about using the Trigger Ready signal with scA750-60 gm/gc cameras, see Section 6.7.2 on page 105.

6.7 Trigger Ready Signal

6.7.1 Trigger Ready Signal (All Models Except scA750-60)

Note

The information in this section applies to all camera models except the scA750-60 fm/fc. For information about scA750-60 cameras, see Section 6.7.2 on page 105.

As described in the previous section, the cameras can operate in an “overlapped” exposure fashion. When the camera is operated in this manner, it is especially important that:

- the exposure time of a new image capture not start until the exposure time of the previously captured image is complete, and
- the exposure time of a newly captured image not end until readout of the previously captured image is complete.

The camera supplies a “Trigger Ready” (TrigRdy) output signal you can use to ensure that these conditions are met when you are using a hardware trigger signal to trigger image capture. When you are capturing images, the camera automatically calculates the earliest moment that it is safe to trigger each new capture. The trigger ready signal will go high when it is safe to trigger a capture, will go low when the capture has started, and will go high again when it is safe to trigger the next capture (see Figure 50). The camera calculates the rise of the trigger ready signal based on the current exposure time setting, the current size of the area of interest, and the time it will take to readout the captured pixel values from the sensor.

The trigger ready signal is especially useful if you have the camera set for video format 7 and you want to run the camera at the maximum frame capture rate for the current conditions. If you monitor the trigger ready signal and you begin capture of each new image immediately after the signal goes high, you will be sure that the camera is operating at the maximum frame rate.

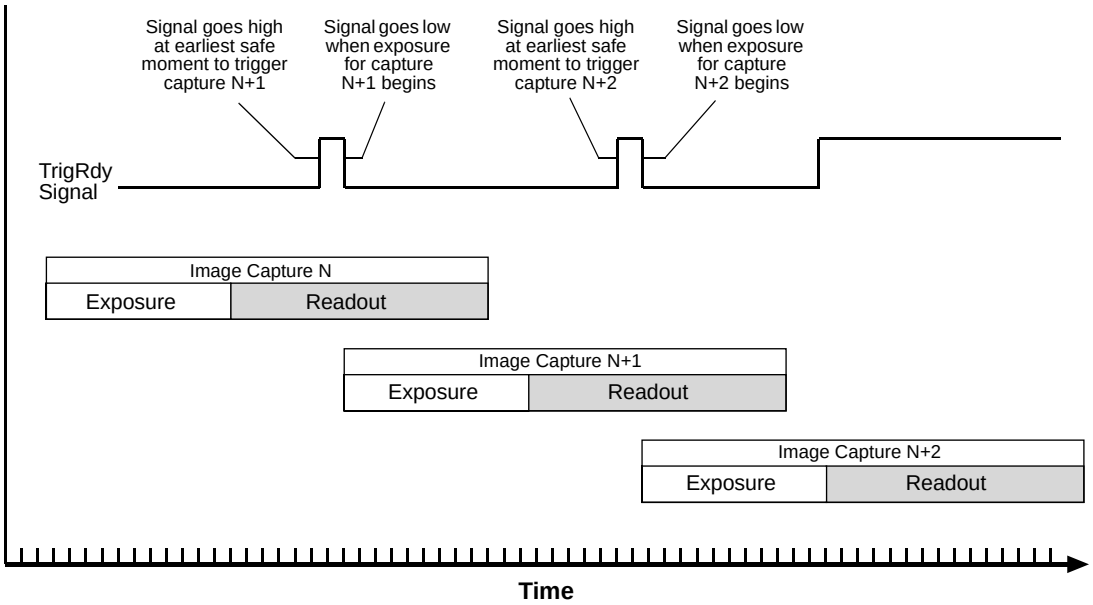


Fig. 50: Trigger Ready Signal

You should be aware that there are some camera settings that can affect the operation of the trigger ready signal:

- If the camera is set for external triggering and for video format 0, 1, or 2, the rate at which the trigger ready signal will rise will be determined by the setting in the Frame Rate field of the Current Video Frame Rate/Revision control register.
- If the camera is set for external triggering and for video format 7, the rate at which the trigger ready signal will rise will be determined by the setting in the Frame Rate field of the Frame Rate control register:
  - With the value in the On/Off field is set to 0 (manual control off), the signal will rise at the maximum frame rate allowed with the current camera settings.
  - With the value in the On/Off field is set to 1 (manual control on) and the value in the Frame Rate field is less than the maximum frame rate allowed, the signal will rise at the frame rate specified by the value in the Frame Rate field.
  - With the value in the On/Off field is set to 1 (manual control on) and the value in the Frame Rate field is greater than the maximum frame rate allowed, the signal will rise at the maximum allowed rate.

Note

If you attempt to start an image capture when the trigger ready signal is low, the camera will simply ignore the attempt.

The trigger ready signal will only be available when hardware triggering is enabled.

By default, the trigger ready signal is assigned to physical output port 1 on the camera. However, the assignment of the trigger signal to a physical output port can be changed.

For more information about changing the assignment of camera output signals to physical output ports, see Section 9.6.7 on page 216.

For more information about the electrical characteristics of the camera's output ports, see Section 4.7.2 on page 78.

For more information about using an external hardware trigger signal, see Section 6.3 on page 91.

For more information on video formats, see Section 7 on page 113.

For more information about the maximum allowed frame rate in format 7, see Section 7.2.2 on page 118.

6.7.2 Trigger Ready Signal (scA750-60 Only)

Note

The information in this section only applies to scA750-60 fm/fc cameras. For information about the other camera models, see Section 6.7.1 on page 103.

As described in an earlier section, on these cameras the exposure for an image capture must not begin until readout of the previously captured image has ended. The camera supplies a "Trigger Ready" (TrigRdy) output signal you can use to ensure that these conditions are met when you are using a hardware trigger signal to trigger image capture. When you are capturing images, the camera automatically calculates the earliest moment that it is safe to trigger each new capture. The trigger ready signal will go high when it is safe to trigger a capture, will go low when the capture has started, and will go high again when it is safe to trigger the next capture (see Figure 50). The camera calculates the rise of the trigger ready signal based on the current shutter settings, the current size of the area of interest, and the time it will take to readout the captured pixel values from the sensor.

The trigger ready signal is especially useful if you have the camera set for video format 7 and you want to run the camera at the maximum frame capture rate for the current conditions. If you monitor

the trigger ready signal and you begin capture of each new image immediately after the signal goes high, you will be sure that the camera is operating at the maximum frame rate.

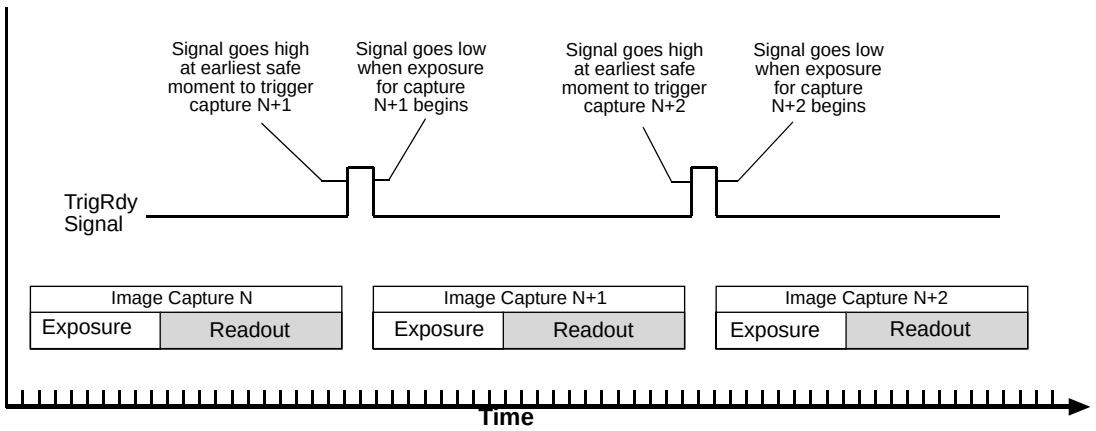


Fig. 51: Trigger Ready Signal

You should be aware that there are some camera settings that can affect the operation of the trigger ready signal:

- If the camera is set for external triggering and for video format 0, 1, or 2, the rate at which the trigger ready signal will rise will be determined by the setting in the Frame Rate field of the Current Video Frame Rate/Revision control register.
- If the camera is set for external triggering and for video format 7, the rate at which the trigger ready signal will rise will be determined by the setting in the Frame Rate field of the Frame Rate control register:
  - With the value in the On/Off field is set to 0 (manual control off), the signal will rise at the maximum frame rate allowed with the current camera settings.
  - With the value in the On/Off field is set to 1 (manual control on) and the value in the Frame Rate field is less than the maximum frame rate allowed, the signal will rise at the frame rate specified by the value in the Frame Rate field.
  - With the value in the On/Off field is set to 1 (manual control on) and the value in the Frame Rate field is greater than the maximum frame rate allowed, the signal will rise at the maximum allowed rate.

Note

If you attempt to start an image capture when the trigger ready signal is low, the camera will simply ignore the attempt.

The trigger ready signal will only be available when hardware triggering is enabled.

By default, the trigger ready signal is assigned to physical output port 1 on the camera. However, the assignment of the trigger signal to a physical output port can be changed.

For more information about changing the assignment of camera output signals to physical output ports, see Section 9.6.7 on page 216.

For more information about the electrical characteristics of the camera's output ports, see Section 4.7.2 on page 78.

For more information about using an external hardware trigger signal, see Section 6.3 on page 91.

For more information on video formats, see Section 7 on page 113.

For more information about the maximum allowed frame rate in format 7, see Section 7.2.2 on page 118.

6.8 Integrate Enabled Signal

The camera's "integrate enabled" (IntEn) signal goes high when the exposure time for each image capture begins and goes low when the exposure time ends as shown in Figure 52. This signal can be used as a flash trigger and is also useful when you are operating a system where either the camera or the object being imaged is movable. For example, assume that the camera is mounted on an arm mechanism and that the mechanism can move the camera to view different portions of a product assembly. Typically, you do not want the camera to move during exposure. In this case, you can monitor the IntEn signal to know when exposure is taking place and thus know when to avoid moving the camera.

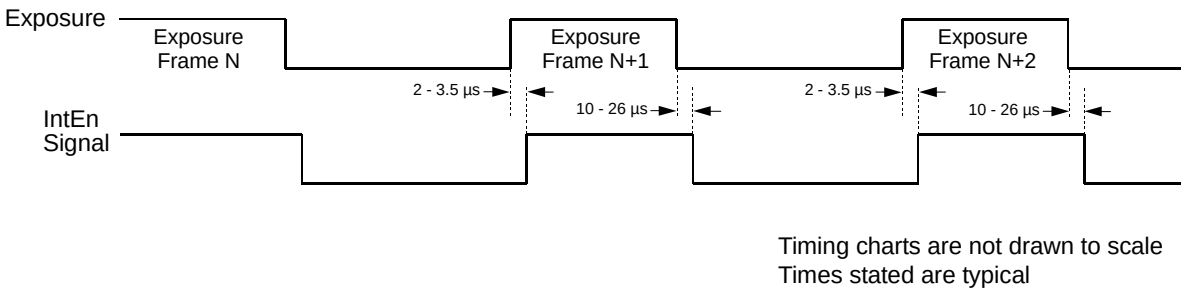


Fig. 52: Integrate Enabled Signal

By default, the IntEn signal is assigned to physical output port 0 on the camera. However, the assignment of the IntEn signal to a physical output port can be changed.

Note

When you use the integrate enabled signal, be aware that there is a small delay in the rise and the fall of the signal in relation to the start and the end of exposure. See Figure 52 for details

For more information about changing the assignment of camera output signals to physical output ports, see Section 9.6.7 on page 216.

For more information about the electrical characteristics of the camera's output ports, see Section 4.7.2 on page 78.

6.9 Image Exposure and Transmission Timing Chart

Figure 53 shows a timing chart for image exposure and transmission. The chart assumes that exposure is triggered with an ExTrig signal with rising edge activation and that the camera is set for programmable exposure mode.

As Figure 53 shows, there is a slight delay between the rise of the ExTrig signal and the start of exposure. After the exposure time for an image capture is complete, the camera begins reading out the captured image data from the CCD sensor into a buffer in the camera. When the camera has determined that a sufficient amount of image data has accumulated in the buffer, it will begin transmitting the data from the camera to the host PC.

This buffering technique avoids the need to exactly synchronize the clock used for sensor readout with the clock used for data transmission over the IEEE 1394b bus. The camera will begin transmitting data when it has determined that it can safely do so without over-running or under-running the buffer. This buffering technique is also an important element in achieving the highest possible frame rate with the best image quality.

The **exposure start delay** is the amount of time between the point where the trigger signal transitions to the point where exposure actually begins.

The **frame readout time** is the amount of time it takes to read out the data for a captured image from the CCD sensor into the image buffer.

The **time to transmission end** is the amount of time between the point where the camera begins reading out the captured image data from the sensor to the point where it finishes transmitting the data for the captured image from the buffer to the host PC.

The exposure start delay varies from camera model to camera model. Table 13 shows the exposure start delay for each camera model:

Camera Model	Exposure Start Delay
scA640-70fm/fc	31.37 µs
scA640-74fm/fc	29.87 µs
scA750-60fm/fc	180.0 µs
scA780-54fm/fc	31.89 µs
scA1000-20fm/fc	64.91 µs
scA1000-30fm/fc	45.33 µs
scA1300-32fm/fc	32.17 µs
scA1390-17fm/fc	58.90 µs
scA1400-17fm/fc	57.71 µs
scA1400-30fm/fc	33.40 µs

Table 13: Exposure Start Delays

Camera Model	Exposure Start Delay
scA1600-14fm/fc	60.52 µs

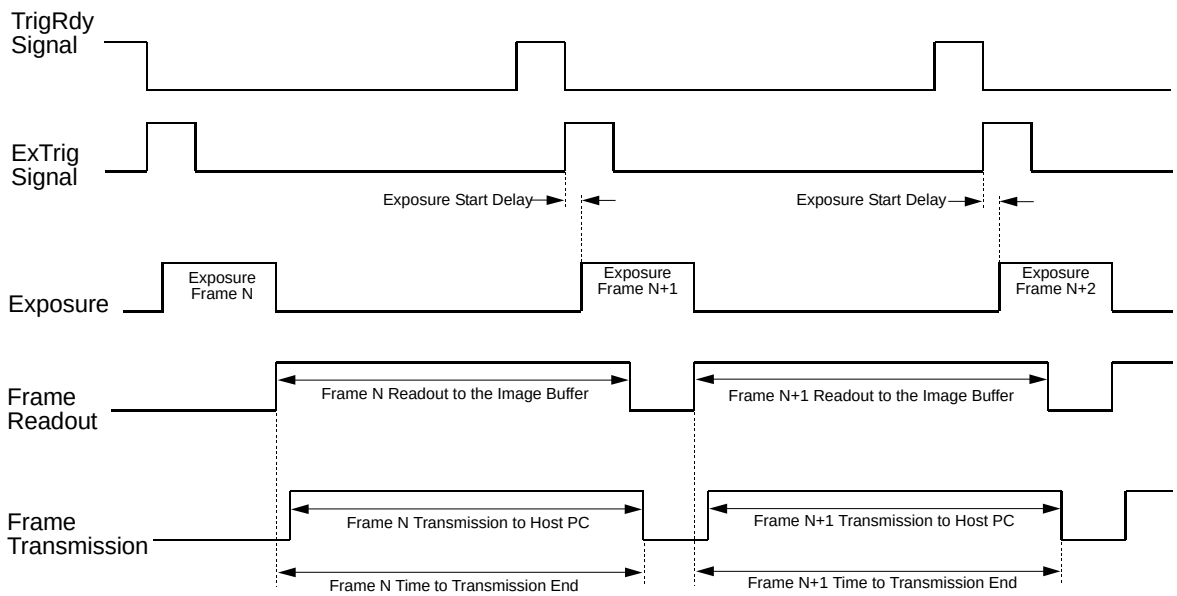
Table 13: Exposure Start Delays

Note that, if the debouncer feature is used, the debouncer setting for the input port must be added to the exposure start delays shown in Table 13 to determine the total start delay. For example, assume that you are using an scA640-70 camera and that you have set the cameras for hardware triggering. Also assume that you have selected input port 1 to accept the hardware trigger signal and that you have set the Input Debouncer Time 1 parameter to 5 µs. In this case:

Total Start Delay = Start Delay from Table 13 + Debouncer Setting

Total Start Delay = 31.37 µs+ 5 µs

Total Start Delay = 36.37 µs



Timing charts are not drawn to scale

Fig. 53: Exposure Start Controlled with an ExTrig Signal

You can calculate the frame readout time by using this formula:

Frame Readout Time = T_r = (AOI Height x C_1) + C_2

Where the values for the constants C1 and C2 are from the table in Section 7.2.2 on page 118 for all camera models except the scA750-60 or from the table in Section 7.2.3 on page 123 for scA750-60 cameras.

You can calculate the time to transmission end (T_e) using these three steps:

1. Calculate the frame readout time (T_r) using the formula above.
2. Calculate the base transmission time (T_b) using this formula:

   T_b = Packets/frame x 125 µs
3. Compare the results:

   If $T_b \leq T_r$, then $T_e = T_r + 250$ µs

   If $T_b > T_r$, then $T_e = T_b + 250$ µs

If you are operating the camera in video format 7, you can determine the number of packets transferred per frame by checking the value of the Packets Per Frame field in the Packets Per Frame inquiry register.

For more information about standard video format, mode, and frame rate combinations, see Section 7.1 on page 113.

For more information about video format 7, see Section 7.2 on page 115.

For more information about the Packets Per Frame inquiry register, see page 278.

7 Video Formats, Modes, and Frame Rates

This section provides detailed information about the standard video data format, mode, and frame rate combinations available on the camera. It also describes format 7, the "flexible" format.

7.1 Standard Format, Mode, and Frame Rate Combinations

You can set your camera for a standard video format, mode, and frame rate combination. When you set the camera for a standard combination, you are selecting the image resolution, the image color coding, and the frame rate that the camera will use. For example, if you set a camera to the video format 0 / video mode 5 / video frame rate 3 combination, you would be setting the camera to operate at 640 x 480 resolution with a mono 8 color coding and a 15 frames per second rate. The standard video format, mode, and frame rate combinations are specified in the 1394 Trade Association DCAM standard.

When you set the video format and the video mode, you determine the size of the captured images and the color coding for the pixel data that will be transmitted from the camera. The color coding determines the format of the pixel data that will be output from the camera.

The standard combinations available vary depending on the camera model you are using. You can determine if a particular combination is available on your camera model by checking the inquiry registers for video formats, the inquiry registers for video modes, and the inquiry registers for video frame rates.

Section 7.3.2 on page 130 contains detailed descriptions of the color codings available when you are operating the camera in the "flexible" video format. Those descriptions also apply to the color codings for the standard combinations.

The value of the Format field in the Current Video Format control register sets the video format. The value of the Mode field in the Current Video Mode control register sets the video mode. The value of the Frame Rate/Revision filed in the Current Video Frame Rate/Revision control register sets the video frame rate. Note that the meaning of the frame rate setting varies depending on how you are using the camera:

- If you are operating the camera in continuous shot mode without using triggering, the frame rate setting sets the rate at which the camera will capture images. In this situation, setting the camera to operate at a frame rate of 15, for example, would cause the camera to capture images at a rate of 15 frames per second.
- If you are using a series of one shot commands to start each exposure or if you are starting each exposure with a software trigger or an external trigger, the frame rate setting limits the

maximum rate at which you can trigger image capture. In this situation, setting the camera to operate at a frame rate of 15 would limit the maximum rate at which you can trigger exposure starts to 15 times per second.

Note

If you are using long exposure times, this can restrict the camera's maximum frame rate. If the exposure time is restricting the frame rate to a rate that is lower than the frame rate setting, the camera will capture images at the lower rate.

For more information about the standard format, mode, and frame rate inquiry registers, see Section 11.1.3 on page 236.

For more information about the Current Video Format, Current Video Mode, and Current Video Frame Rate/Revision control registers, see Section 11.2.1 on page 261.

The Basler BCAM 1394 Driver includes method calls for inquiring which standard video formats, modes, and frame rates are available. It also includes method calls for selecting a standard format, mode, and frame rate. For more information, see the online documentation delivered with the BCAM Driver.

7.2 Format 7

Video format 7 is commonly known as the "flexible" video format. When the camera is set to use format 7, the image resolution, color coding, and frame rate are not automatically selected as they are when you use a standard format / mode / frame rate combination. Instead, you can individually control the camera's resolution, color coding, and frame rate. The selection of a particular color coding determines the format of the pixel data that will be output by the camera.

When you are operating a camera in video format 7, you must also select a video mode. Only one video mode is available for use with format 7 - mode 0.

To set the camera for video format 7, set the value of the Format field in the camera's Current Video Format control register to 7. To set the video mode to mode 0, set the Mode field of the Current Video Mode control register to 0.

For more information about the color codings, see Section 7.3.2 on page 130.

The Basler BCAM 1394 Driver includes method calls for selecting the format and mode. For more information, see the online documentation delivered with the BCAM Driver.

Setting the Area of Interest

When the camera is operating in format 7, you can specify a portion of the CCD sensor array and after each image is captured, only the pixel information from the specified portion of the array is transmitted to the host PC. This ability is known as the area of interest (AOI) feature.

The area of interest is referenced to the top left corner of the CCD array. The top left corner is designated as column 0 and row 0 as shown in Figure 54.

The location and size of the area of interest is defined by declaring a left-most column, a width, a top row, and a height. For example, suppose that you specify the left column as 10, the width as 16, the top row as 6, and the height as 10. The area of the array that is bounded by these settings is shown in Figure 54.

The camera will only transfer pixel data from within the area defined by your settings. Information from the pixels outside of the area of interest is discarded.

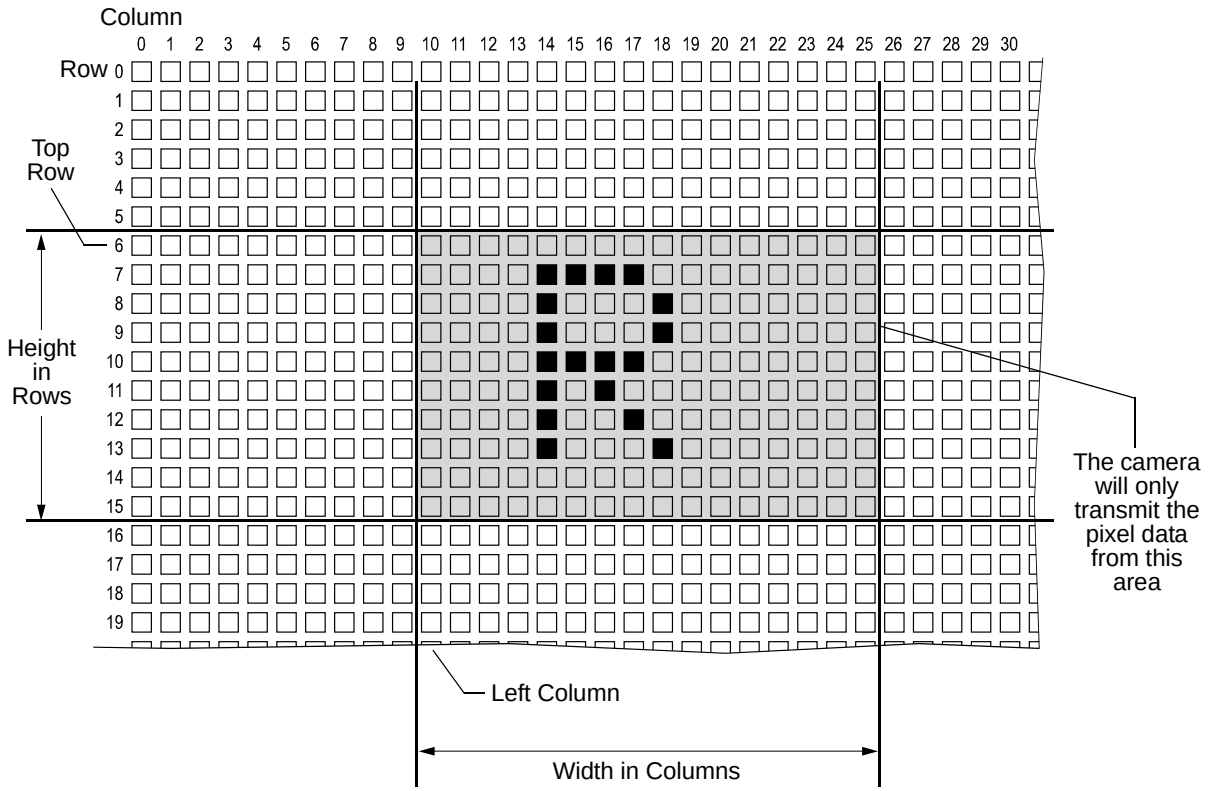

Column
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Row
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
Top Row
Height in Rows
The camera will only transmit the pixel data from this area
Left Column
Width in Columns

Fig. 54: Area of Interest

One of the main advantages of the AOI feature is that decreasing the height of the AOI can increase the camera's maximum allowed frame capture rate.

For more information about the maximum allowed frame rate in format 7, see Section 7.2.2 on page 118.

Except for the scA1300-32 camera, the AOI is set to use the full resolution of the camera's sensor. For the scA1300-32 cameras, the default resolution is set to 1280 x 960 pixels for mono models, and to 1278 x 958 pixels for color models.

To change the setting for the left column, change the value of the Left field in the Image Position control register for format 7.

To change the setting for the top row, change the value of the Top field in the Image Position control register for format 7.

To change the setting for the width, change the value of the Width field in the Image Size control register for format 7.

To change the setting for the height, change the value of the Height field in the Image Size control register for format 7.

Guidelines for the AOI Settings

When you are setting the camera's area of interest, you must follow these guidelines on all camera models:

- The sum of the current Left setting plus the current Width setting must not exceed the maximum width of the sensor in the camera model you are using. For example, on the scA640-70fm, the sum of the current Left setting plus the current Width setting must not exceed 659.
- The sum of the current Top setting plus the current Height setting must not exceed the maximum height of the sensor in the camera model you are using. For example, on the scA640-70fm, the sum of the current Top setting plus the current Height setting must not exceed 494.

On monochrome cameras:

- The Left, Top, Width, and Height settings can be set in increments of 1.

On color cameras:

- The Left, Top, Width, and Height settings can be set in increments of 2 and they must be set to an even number. For example, the Left parameter can be set to 0, 2, 4, 6, 8, etc.

Note

Normally, the Left, Top, Width, and Heigth settings refer to the physical columns and lines in the sensor. But if binning is enabled, these parameters are set in terms of "virtual" columns and lines. For more information, see Section 9.6.2 on page 190.

The Basler BCAM 1394 Driver includes method calls for setting the position and size of the AOI. For more information, see the online documentation delivered with the BCAM Driver.

7.2.1 Setting the Frame Rate in Format 7

When you are operating the camera in video format 7, the frame rate is not fixed as it is with standard video formats. The way that you regulate the frame rate in format 7 depends on the exposure control method you are using:

- If you are using a series of one-shot commands without triggering, the frame rate will be determined by the rate at which you issue the one-shot commands.
- If you are using a series of one-shot commands with software or hardware triggering, the frame rate will be determined by the rate at which you issue one-shot commands and the triggers.
- If using the continuous-shot exposure method without triggering, the frame rate will be determined by the value in the Frame Rate field of the Frame Rate control register.
- If you are using the continuous-shot exposure method with software or hardware triggering, the frame rate will be determined by the rate at which you issue the triggers.

Section 6 on page 85 contains detailed explanations of each exposure control method and includes information about how the camera's frame rate is regulated with each method.

Note

Several camera settings can restrict the maximum frame rate that can be achieved when the camera is operating in format 7. For detailed information about calculating the maximum allowed frame rate based on the current camera settings, see the next section of this manual.

7.2.2 Maximum Allowed Frame Rate in Format 7 (All Models Except scA750-60)

Note

The information in this section applies to all camera models except the scA750-60 fm/fc. For information about scA750-60 cameras, see Section 7.2.3 on page 123.

When you are operating the camera in video format 7, the maximum allowed frame rate for your camera can be limited by three factors:

- The amount of time it takes to read a captured image out of the imaging sensor and into the camera's frame buffer (a captured image is also known as a frame). This time varies

depending on the height of the frame. Shorter frames take less time to read out of the sensor. The frame height is determined by the camera's AOI Height settings.

- The exposure time for captured frames. If you use very long exposure times, you can capture fewer frames per second.
- The number of packets needed to transfer a captured frame from the camera to your PC.

To determine the maximum allowed frame rate with your current camera settings, calculate a result for each of the three formulas that appear below. The formula that returns the lowest value will determine the maximum frame rate allowed. In other words, the factor that restricts the rate the most will determine the maximum allowed frame rate.

Formula 1:

Calculates the maximum frame rate based on the sensor readout time:

$$\text{Max. Frames/s} = \frac{1}{(\text{AOI Height} \times C_1) + C_2}$$

Where:

AOI Height = the height of the acquired frames as determined by the AOI settings.

The constants C_1 and C_2 depend on the camera model as shown in the table below:

	scA640-70 fm/fc	scA640-74 fm/fc	scA780-54 fm/fc	scA1000-20 fm/fc	scA1000-30 fm/fc	scA1300-32 fm/fc	scA1390-17 fm/fc	scA1400-17 fm/fc
C_1	25.21 µs	24.01 µs	25.70 µs	51.13 µs	36.57 µs	25.21 µs	44.71 µs	44.37 µs
C_2	1623 µs	1546 µs	2231 µs	7822 µs	4699 µs	5367.03 µs	12215 µs	11465 µs

	scA1400-30 fm/fc	scA1600-14 fm/fc
C_1	25.80 µs	52.37 µs
C_2	6450 µs	6896 µs

For more information about AOI settings, see Section on page 115.

Formula 2:

Calculates the maximum frame rate based on the exposure time for the acquired frames:

$$\text{Max. Frames/s} = \frac{1}{\text{Exposure time in µs} + C_3}$$

Where the constant C_3 depends on the camera model as shown in the table below:

	scA640-70 fm/fc	scA640-74 fm/fc	scA780-54 fm/fc	scA1000-20 fm/fc	scA1000-30 fm/fc	scA1300-32 fm/fc	scA1390-17 fm/fc	scA1400-17 fm/fc
C_3	94.56 µs	90.06 µs	95.70 µs	194.82 µs	136.47 µs	96.68 µs	176.76 µs	173.83 µs

:

	scA1400-30 fm/fc	scA1600-14 fm/fc
C_3	100.83 µs	181.64 µs

For more information about exposure time settings, see Section 6.4 on page 98.

Formula 3:

Calculates the maximum frame rate based on the number of packets needed to transmit an acquired frame from the camera to your host PC via the IEEE 1394b bus:

$$\text{Max. Frames/s} = \frac{1}{\text{Packets per frame} \times 125\ \text{µs}}$$

When you are operating the camera in video format 7, you can determine the number of packets transferred per frame by checking the value of the Packets per Frame field in the Packets per Frame inquiry register for format 7.

For more information about video format 7, see Section 7.2 on page 115.

For more information about the Packets per Frame inquiry register, see page 278.

Example

Assume that you are using a monochrome scA640-70 camera set for an exposure time of 2000 µs and for 600 x 400 resolution. Also assume that you are operating the camera in video format 7. After making all camera settings, you check the current value of the Packets per Frame field in the Packets per Frame Inquiry register. You find that with the current settings, the packets transferred per frame is 40.

Formula 1:

$$\text{Max Frames/s} = \frac{1}{(400 \times 25.21\ \mu s) + 1623\ \mu s}$$

Max Frames/s = 85.4

Formula 2:

$$\text{Max Frames/s} = \frac{1}{2000\ \mu s + 94.56\ \mu s}$$

Max Frames/s = 477.4

Formula 3:

$$\text{Max Frames/s} = \frac{1}{40 \times 125\ \mu s}$$

Max Frames/s = 200

Formula one returns the lowest value. So in this case, the limiting factor is the sensor readout time and the maximum allowed frame capture rate would be 85.4 frames per second.

Increasing the Maximum Allowed Frame Rate

You may find that you would like to capture frames at a rate higher than the maximum allowed with the camera's current settings. In this case, you must first use the three formulas described above to determine what factor is restricting the maximum frame rate the most. Next, you must try to make that factor less restrictive:

- You will often find that the sensor readout time is most restrictive factor. Decreasing the height of the captured frames will decrease the sensor readout time and will make this factor less restrictive.
- If you are using normal exposure times and you are using the camera at it's maximum resolution, your exposure time will not normally be the most restrictive factor on the frame rate. However, if you are using long exposure times or small areas of interest, it is quite possible to find that your exposure time is the most restrictive factor on the frame rate. In this case, you should lower your exposure time. (You may need to compensate for a lower exposure time by using a brighter light source or increasing the opening of your lens aperture.)
- If you find that the number of packets needed to transmit an image is restricting the frame rate, you may be able to decrease the number of packets needed per frame. The next section explains more about decreasing the packets per frame.

7.2.2.1 Effect of the Bytes Per Packet Setting on the Maximum Allowed Frame Rate

After a camera acquires an image, the image data is read out from the sensor into a buffer. Once the frame has been read out to the buffer, the data is packetized and transmitted across the IEEE 1394b bus to your host PC.

When you are operating the camera in format 7, a setting called the Bytes Per Packet determines the number of bytes of data that will be included in each packet transferred across the bus. The minimum value for the Bytes Per Packet parameter is 4 and the maximum value is 8192. By default the Bytes Per Packet is set to the maximum and has no noticeable effect on the operation of the camera.

If you are using a single camera on your IEEE 1394b bus, you would ordinarily leave the Bytes Per Packet setting at the maximum. However, if you are operating multiple cameras on a single IEEE 1394b bus, you will probably need to change the Bytes Per Packet setting so that the cameras can effectively share the available bus bandwidth.

If you lower the value of the Bytes Per Packet setting, the amount of image data included in each packet transmitted across the bus will be lower. This means that it will take more packets to transmit each frame and since the cycle time of the IEEE 1394b bus is fixed, it also means that it will take more time to transmit each frame. If you lower the Bytes Per Packet setting enough, the slower data transfer rate can begin to affect the maximum allowed frame capture rate of your camera. If you look at the formulas at the beginning of this section, you will notice that one of the factors that can limit the maximum allowed frame rate is the number of packets needed to transmit a frame. The number of packets per frame is directly related to the Bytes Per Packet setting.

You can see the effect of changing the Bytes Per Packet setting by looking at the read only setting called Packets Per Frame. The Packets Per Frame parameter indicates the number of packets needed to transmit a frame with the current camera settings. If you decrease the setting for the Bytes Per Packet, you will notice that the value of the Packets Per Frame will increase.

To change the Bytes Per Packet setting, change the value of the Bytes per Packet field of the Bytes per Packet control register.

The Basler BCAM 1394 Driver includes method calls for setting the Bytes per Packet. For more information, see the online documentation delivered with the BCAM Driver.

For more information about using multiple cameras on a single bus, see Section 10 on page 229.

7.2.3 Maximum Allowed Frame Rate in Format 7 (scA750-60 Only)

Note

The information in this section only applies to scA750-60 fm/fc cameras. For information about the other camera models, see Section 7.2.2 on page 118.

When you are operating the camera in video format 7, the maximum allowed frame rate for your camera can be limited by two factors:

- The sum of the exposure time plus the amount of time it takes to read the captured image out of the imaging sensor and into the camera's frame buffer (a captured image is also known as a frame).

  The exposure time is set by the user. If you use very long exposure times, you can capture fewer frames per second.

  The readout time varies depending on the height of the frame. Shorter frames take less time to read out of the sensor. The frame height is determined by the camera's AOI Height settings.
- The number of packets needed to transfer a captured frame from the camera to your PC.

To determine the maximum allowed frame rate with your current camera settings, calculate a result for each of the two formulas that appear below. The formula that returns the lowest value will determine the maximum frame rate allowed. In other words, the factor that restricts the rate the most will determine the maximum allowed frame rate.

For more information about AOI settings, see Section on page 115.

Formula 1:

Calculates the maximum frame rate based on the sum of the exposure time plus the sensor readout time:

$$\text{Max. Frames/s} = \frac{1}{\text{Exposure Time in µs} + (\text{AOI Height} \times C_1) + C_2}$$

Where:

AOI Height = the height of the acquired frames as determined by the AOI settings.

The constants C_1 and C_2 depend on the camera model as shown in the table below:

	scA750-60 fm/fc
C_1	31.0 µs
C_2	397.0 µs

For more information about exposure time settings, see Section 6.4 on page 98.

Formula 2:

Calculates the maximum frame rate based on the number of packets needed to transmit an acquired frame from the camera to your host PC via the IEEE 1394b bus:

$$\text{Max. Frames/s} = \frac{1}{\text{Packets per frame} \times 125\ \mu s}$$

When you are operating the camera in video format 7, you can determine the number of packets transferred per frame by checking the value of the Packets per Frame field in the Packets per Frame inquiry register for format 7.

For more information about video format 7, see Section 7.2 on page 115.

For more information about the Packets per Frame inquiry register, see page 278.

Example

Assume that you are using a monochrome scA6750-60 camera set for an exposure time of 2000 µs and for 600 x 400 resolution. Also assume that you are operating the camera in video format 7. After making all camera settings, you check the current value of the Packets per Frame field in the Packets per Frame Inquiry register. You find that with the current settings, the packets transferred per frame is 40.

Formula 1:

$$\text{Max Frames/s} = \frac{1}{2000\ \mu s + (400 \times 31.0\ \mu s) + 397.0\ \mu s}$$

Max Frames/s = 67.6

Formula 2:

$$\text{Max Frames/s} = \frac{1}{40 \times 125\ \mu s}$$

Max Frames/s = 200

Formula one returns the lowest value. So in this case, the limiting factor is the sum of the exposure time plus the sensor readout time and the maximum allowed frame capture rate would be 67.6 frames per second.

Increasing the Maximum Allowed Frame Rate

You may find that you would like to capture frames at a rate higher than the maximum allowed with the camera's current settings. In this case, you must first use the two formulas described above to determine what factor is restricting the maximum frame rate the most. Next, you must try to make that factor less restrictive:

- You will often find that the sum of the exposure time plus the sensor readout time is the most restrictive factor.

  Decreasing the AOI height for the captured frames will decrease the sensor readout time and will make this factor less restrictive.

  If you are using long exposure times, it is quite possible to find that your exposure time is making this factor the most restrictive. In this case, you should lower your exposure time. (You may need to compensate for a lower exposure time by using a brighter light source or increasing the opening of your lens aperture.)
- If you find that the number of packets needed to transmit an image is restricting the frame rate, you may be able to decrease the number of packets needed to transmit a frame. The next section in this manual explains more about the effect of changing the packets per frame.

7.2.3.1 Effect of the Bytes Per Packet Setting on the Maximum Allowed Frame Rate

After a camera acquires an image, the image data is read out from the sensor into a buffer. Once the frame has been read out to the buffer, the data is packetized and transmitted across the IEEE 1394b bus to your host PC.

When you are operating the camera in format 7, a setting called the Bytes Per Packet determines the number of bytes of data that will be included in each packet transferred across the bus. The minimum value for the Bytes Per Packet parameter is 4 and the maximum value is 8192. By default the Bytes Per Packet is set to the maximum and has no noticeable effect on the operation of the camera.

If you are using a single camera on your IEEE 1394b bus, you would ordinarily leave the Bytes Per Packet setting at the maximum. However, if you are operating multiple cameras on a single IEEE 1394b bus, you will probably need to change the Bytes Per Packet setting so that the cameras can effectively share the available bus bandwidth.

If you lower the value of the Bytes Per Packet setting, the amount of image data included in each packet transmitted across the bus will be lower. This means that it will take more packets to transmit each frame and since the cycle time of the IEEE 1394b bus is fixed, it also means that it will take more time to transmit each frame. If you lower the Bytes Per Packet setting enough, the slower data transfer rate can begin to affect the maximum allowed frame capture rate of your camera. If you look at the formulas at the beginning of this section, you will notice that one of the factors that can limit the maximum allowed frame rate is the number of packets needed to transmit a frame. The number of packets per frame is directly related to the Bytes Per Packet setting.

You can see the effect of changing the Bytes Per Packet setting by looking at the read only setting called Packets Per Frame. The Packets Per Frame parameter indicates the number of packets

needed to transmit a frame with the current camera settings. If you decrease the setting for the Bytes Per Packet, you will notice that the value of the Packets Per Frame will increase.

To change the Bytes Per Packet setting, change the value of the Bytes per Packet field of the Bytes per Packet control register.

The Basler BCAM 1394 Driver includes method calls for setting the Bytes per Packet. For more information, see the online documentation delivered with the BCAM Driver.

For more information about using multiple cameras on a single bus, see Section 10 on page 229.

7.3 The Bayer Filter and Color Creation

The sensor used in color models of the camera is equipped with an additive color separation filter known as a Bayer filter. The pixel data output formats available on color cameras are related to the Bayer pattern, so you need a basic knowledge of the Bayer filter to understand the pixel formats. With the Bayer filter, each individual pixel is covered by a micro-lens that allows light of only one color to strike the pixel. The pattern of the Bayer filter used on the camera is as shown in Figure 55 (the alignment of the Bayer filter with repect to the sensor is shown as an example only; the figure shows the "BG" filter alignment). As the figure illustrates, within each square of four pixels, one pixel sees only red light, one sees only blue light, and two pixels see only green light. (This combination mimics the human eye's sensitivity to color.)

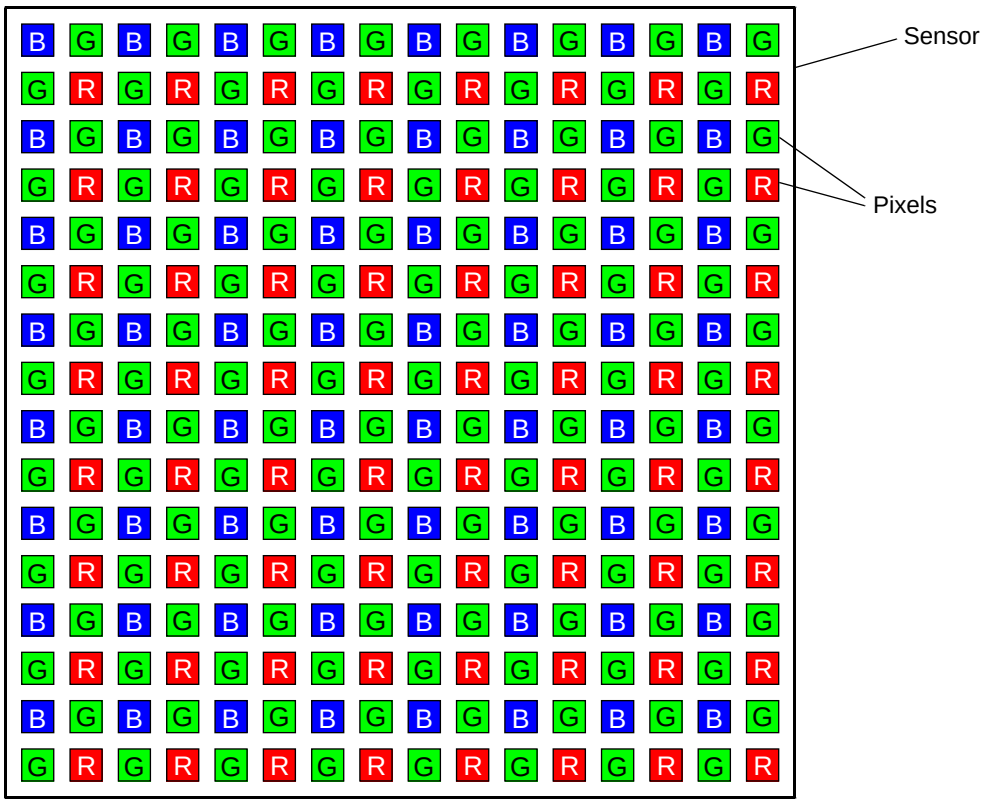


Fig. 55: Bayer Filter Pattern

7.3.1 Color Filter Alignment

The alignment of the Bayer filter to the pixels in the images acquired by color cameras is either Bayer BG / GR or Bayer RG / GB depending on the camera model. Table 14 shows the filter alignment for each available camera model

Color Camera Model	Filter Alignment
scA640-70	BG / GR
scA640-74	BG / GR
scA750-60	RG / GB
scA780-54	BG / GR
scA1000-20	BG / GR
scA1000-30	BG / GR
scA1300-32	BG / GR
scA1390-17	BG / GR
scA1400-17	BG / GR
scA1400-30	BG / GR
scA1600-14	BG / GR

Table 14: Bayer Filter to Sensor Alignment

Bayer BG / GR alignment means that pixel one and pixel two of the first line in each image transmitted will be blue and green respectively. And for the second line transmitted, pixel one and pixel two will be green and red respectively. Since the pattern of the Bayer filter is fixed, you can use this information to determine the color of all of the other pixels in the image.

Bayer RG / GB alignment means that pixel one and pixel two of the first line in each image transmitted will be red and green respectively. And for the second line transmitted, pixel one and pixel two will be green and blue respectively. Since the pattern of the Bayer filter is fixed, you can use this information to determine the color of all of the other pixels in the image.

Because the size and position of the area of interest on color cameras must be adjusted in increments of 2, the color filter alignment will remain the same regardless of the camera’s area of interest (AOI) settings.

A value known as the Color Filter ID indicates the alignment of the camera's Bayer filter to the pixels in the images captured by a color camera. You can tell how the AOI is aligned to the Bayer filter by reading the Filter ID field in the Color Filter ID inquiry register for format 7. The field will contain a numerical ID that indicates the alignment of the Bayer filter as shown in Table 15.

ID	Alignment
0	RG / GB
1	GB / RG
2	GR / BG
3	BG / GR

Table 15: Color Filter IDs

The Basler BCAM 1394 Driver does not include a method call to access the Color Filter ID inquiry register. As a work around, you can use the Basler Smart Features Framework software to directly read from the register. For more information about the Smart Features Framework software, see Section 9.2 on page 169.)

7.3.2 Color Codings

The camera's color coding setting determines the format of the image data that will be output from the camera. The available color coding settings depend on the camera model and whether the camera is monochrome or color. Table 16 lists the color coding available on each monochrome camera model and Table 17 lists the color codings available on each color camera model.

Mono Camera Model	Mono 8	Mono 16	Mono 12 Packed	YUV 4:2:2	YUV 4:2:2 (YUYV)
scA640-7	•	•	•	•	•
scA640-74	•	•	•	•	•
scA750-60	•			•	•
scA780-54	•	•	•	•	•
scA1000-20	•	•	•	•	•
scA1000-30	•	•	•	•	•
scA1300-32	•	•	•	•	•
scA1390-17	•	•	•	•	•
scA1400-17	•	•	•	•	•
scA1400-30	•	•	•	•	•
scA1600-14	•	•	•	•	•

Table 16: Color Codings Available on Monochrome Cameras (• = format available)

Color Camera Model	Mono 8	Raw 8	Raw 16	Raw 12 Packed	YUV 4:2:2	YUV 4:2:2 (YUYV)
scA640-70	•	•	•	•	•	•
scA640-74	•	•	•	•	•	•
scA750-60	•	•			•	•
scA780-54	•	•	•	•	•	•
scA1000-20	•	•	•	•	•	•
scA1000-30	•	•	•	•	•	•
scA1300-32	•	•	•	•	•	•
scA1390-17	•	•	•	•	•	•
scA1400-17	•	•	•	•	•	•
scA1400-30	•	•	•	•	•	•
scA1600-14	•	•	•	•	•	•

Table 17: Color Codings Available on Color Cameras (• = format available)

The color coding is selected by setting the value in the Coding ID field of the Color Coding ID control register for format 7. Note that each color coding has a numerical ID and the ID number is entered in the Color Coding ID field.

The details of each color coding are provided in the next sections.

The Basler BCAM 1394 Driver includes method calls for setting the Color Coding ID in format 7. For more information, see the online documentation delivered with the BCAM Driver.

7.3.2.1 Mono 8 on Monochrome Cameras (ID 0)

When a monochrome camera is set for the Mono 8 color coding, it outputs 8 bits of brightness data per pixel.

The table below describes how the pixel data for a received frame will be ordered in the image buffer in your PC when the camera is set for Mono 8 output.

The following standards are used in the table:

P_0 = the first pixel transmitted by the camera

P_n = the last pixel transmitted by the camera

B_0 = the first byte in the buffer

B_m = the last byte in the buffer

Byte	Data
B_0	Brightness value for P_0
B_1	Brightness value for P_1
B_2	Brightness value for P_2
B_3	Brightness value for P_3
B_4	Brightness value for P_4
B_5	Brightness value for P_5
B_6	Brightness value for P_6

Byte	Data
B_7	Brightness value for P_7
•	•
•	•
B_{m-3}	Brightness value for P_{n-3}
B_{m-2}	Brightness value for P_{n-2}
B_{m-1}	Brightness value for P_{n-1}
B_m	Brightness value for P_n

When a monochrome camera set for Mono 8, the pixel data output is 8 bit data of the “unsigned char” type. The available range of data values and the corresponding indicated signal levels are as shown in the table below.

This Data Value (Hexadecimal)	Indicates This Signal Level (Decimal)
0xFF	255
0xFE	254
•	•
•	•
•	•
0x01	1
0x00	0

7.3.2.2 Mono 8 on Color Cameras (ID 0)

When a color camera is set for the Mono 8 color coding, the pixel values in each captured image are first interpolated and converted to the YUV color model. The camera then transmits the 8 bit Y value for each pixel to the host PC. In the YUV color model, the Y component for each pixel represents a brightness value. This brightness value can be considered as equivalent to the value that would be sent from a pixel in a monochrome camera. So in essence, when a color camera is set for Mono 8, it outputs an 8 bit monochrome image. (This type of output is sometimes referred to as "Y Mono 8".)

For more information about YUV, see Section 7.3.2.8 on page 144.

The table below describes how the pixel data for a received frame will be ordered in the image buffer in your PC when a color camera is set for Mono 8 output.

The following standards are used in the table:

P_0 = the first pixel transmitted by the camera

P_n = the last pixel transmitted by the camera

B_0 = the first byte in the buffer

B_m = the last byte in the buffer

Byte	Data
B_0	Y value for P_0
B_1	Y value for P_1
B_2	Y value for P_2
B_3	Y value for P_3
B_4	Y value for P_4
B_5	Y value for P_5
B_6	Y value for P_6

Byte	Data
B_7	Y value for P_7
•	•
•	•
•	•
B_{m-3}	Y value for P_{n-3}
B_{m-2}	Y value for P_{n-2}
B_{m-1}	Y value for P_{n-1}

When a color camera is set for Mono 8, the pixel data output is 8 bit data of the “unsigned char” type. The available range of data values and the corresponding indicated signal levels are as shown in the table below.

This Data Value (Hexadecimal)	Indicates This Signal Level (Decimal)
0xFF	255
0xFE	254
•	•
•	•
•	•
0x01	1
0x00	0

7.3.2.3 Mono 12 Packed on Monochrome Cameras (ID 134)

When a monochrome camera is set for the Mono 12 Packed color coding, it outputs 12 bits of brightness data per pixel. Three bytes transmitted by the camera contains data for two pixels.

The table below describes how the pixel data for a received frame will be ordered in the image buffer in your PC when the camera is set for Mono 12 Packed output. Note that the data is placed in the image buffer in **little endian format**.

The following standards are used in the table:

P_0 = the first pixel transmitted by the camera

P_n = the last pixel transmitted by the camera

B_0 = the first byte in the buffer

B_m = the last byte in the buffer

Byte	**Data**	
B_0	P_0 bits 11 ... 4	
B_1	P_1 bits 3 ... 0	P_0 bits 3 ... 0
B_2	P_1 bits 11 ... 4	
B_3	P_2 bits 11 ... 4	
B_4	P_3 bits 3 ... 0	P_2 bits 3 ... 0
B_5	P_3 bits 11 ... 4	
B_6	P_4 bits 11 ... 4	
B_7	P_5 bits 3 ... 0	P_4 bits 3 ... 0
B_8	P_5 bits 11 ... 4	
B_9	P_6 bits 11 ... 4	
B_{10}	P_7 bits 3 ... 0	P_6 bits 3 ... 0
B_{11}	P_7 bits 11 ... 4	
•	•	
•	•	•
•	•	
B_{m-5}	P_{n-3} bits 11 ... 4	
B_{m-4}	P_{n-2} bits 3 ... 0	P_{n-3} bits 3 ... 0
B_{m-3}	P_{n-2} bits 11 ... 4	
B_{m-2}	P_{n-1} bits 11 ... 4	
B_{m-1}	P_n bits 3 ... 0	P_{n-1} bits 3 ... 0
B_m	P_n bits 11 ... 4	

When a monochrome camera is set for Mono 12 Packed, the pixel data output is 12 bit data of the “unsigned” type. The available range of data values and the corresponding indicated signal levels are as shown in the table below.

This Data Value (Hexadecimal)	Indicates This Signal Level (Decimal)
0x0FFF	4095
0x0FFE	4094
•	•
•	•
•	•
0x0001	1
0x0000	0

7.3.2.4 Mono 16 on Monochrome Cameras (ID = 5)

When a monochrome camera is set for the Mono 16 color coding, it outputs 16 bits of brightness data per pixel with 12 bits effective. The 12 bits of effective pixel data fill from the least significant bit. The four unused most significant bits are filled with zeros.

The table below describes how the pixel data for a received frame will be ordered in the image buffer in your PC when the camera is set for Mono 16 output. Note that the data is placed in the image buffer in **little endian format**.

The following standards are used in the table:

P_0 = the first pixel transmitted by the camera

P_n = the last pixel transmitted by the camera

B_0 = the first byte in the buffer

B_m = the last byte in the buffer

Byte	Data
B_0	Low byte of brightness value for P_0
B_1	High byte of brightness value for P_0
B_2	Low byte of brightness value for P_1
B_3	High byte of brightness value for P_1
B_4	Low byte of brightness value for P_2
B_5	High byte of brightness value for P_2
B_6	Low byte of brightness value for P_3
B_7	High byte of brightness value for P_3
•	•

Byte	Data
•	•
B_{m-7}	Low byte of brightness value for P_{n-3}
B_{m-6}	High byte of brightness value for P_{n-3}
B_{m-5}	Low byte of brightness value for P_{n-2}
B_{m-4}	High byte of brightness value for P_{n-2}
B_{m-3}	Low byte of brightness value for P_{n-1}
B_{m-2}	High byte of brightness value for P_{n-1}
B_{m-1}	Low byte of brightness value for P_n
B_m	High byte of brightness value for P_n

When a monochrome camera is set for Mono 16, the pixel data output is 16 bit data of the “unsigned short (little endian)” type. The available range of data values and the corresponding indicated signal levels are as shown in the table below. Note that for 16 bit data, you might expect a value range from 0x0000 to 0xFFFF. However, with the camera set for Mono 16, only 12 bits of the 16 bits transmitted are effective. Therefore, the highest data value you will see is 0x0FFF indicating a signal level of 4095.

This Data Value (Hexadecimal)	Indicates This Signal Level (Decimal)
0x0FFF	4095
0x0FFE	4094
•	•
•	•
•	•
0x0001	1
0x0000	0

7.3.2.5 Raw 8 on Color Cameras (ID = 9)

When a color camera is set for the Raw 8 color coding, it outputs 8 bits of data per pixel and the pixel data is not processed or interpolated in any way. So, for each pixel covered with a red lens in the sensor's Bayer filter, you get 8 bits of red data. For each pixel covered with a green lens in the filter, you get 8 bits of green data. And for each pixel covered with a blue lens in the filter, you get 8 bits of blue data. (This type of pixel data is sometimes referred to as "raw" output.)

For more information about the Bayer filter, see Section 7.3 on page 127.

The tables below describe how the data for the even lines and for the odd lines of a received frame will be ordered in the image buffer in your PC when the camera is set for Raw 8 output.

The following standards are used in the tables:

P_0 = the first pixel transmitted by the camera for a line

P_n = the last pixel transmitted by the camera a line

B_0 = the first byte of data for a line

B_m = the last byte of data for a line

For Cameras with a RG/GB Bayer Filter Alignment (Color Filter ID = 0)

Even Lines	
Byte	**Data**
B_0	Red value for P_0
B_1	Green value for P_1
B_2	Red value for P_2
B_3	Green value for P_3
B_4	Red value for P_4
B_5	Green value for P_5
•	•
•	•
•	•
B_{m-5}	Red value for P_{n-5}
B_{m-4}	Green value for P_{n-4}
B_{m-3}	Red value for P_{n-3}
B_{m-2}	Green value for P_{n-2}
B_{m-1}	Red value for P_{n-1}
B_m	Green value for P_n

Odd Lines	
Byte	**Data**
B_0	Green value for P_0
B_1	Blue value for P_1
B_2	Green value for P_2
B_3	Blue value for P_3
B_4	Green value for P_4
B_5	Blue value for P_5
•	•
•	•
•	•
B_{m-5}	Green value for P_{n-5}
B_{m-4}	Blue value for P_{n-4}
B_{m-3}	Green value for P_{n-3}
B_{m-2}	Blue value for P_{n-2}
B_{m-1}	Green value for P_{n-1}
B_m	Blue value for P_n

For Cameras with a BG/GR Bayer Filter Alignment (Color Filter ID = 3)

Even Lines	
Byte	**Data**
B_0	Blue value for P_0
B_1	Green value for P_1
B_2	Blue value for P_2
B_3	Green value for P_3
B_4	Blue value for P_4
B_5	Green value for P_5
•	•
•	•
•	•
B_{m-5}	Blue value for P_{n-5}
B_{m-4}	Green value for P_{n-4}
B_{m-3}	Blue value for P_{n-3}
B_{m-2}	Green value for P_{n-2}
B_{m-1}	Blue value for P_{n-1}
B_m	Green value for P_n

Odd Lines	
Byte	**Data**
B_0	Green value for P_0
B_1	Red value for P_1
B_2	Green value for P_2
B_3	Red value for P_3
B_4	Green value for P_4
B_5	Red value for P_5
•	•
•	•
•	•
B_{m-5}	Green value for P_{n-5}
B_{m-4}	Red value for P_{n-4}
B_{m-3}	Green value for P_{n-3}
B_{m-2}	Red value for P_{n-2}
B_{m-1}	Green value for P_{n-1}
B_m	Red value for P_n

With a color camera set for Raw 8, the pixel data output is 8 bit data of the “unsigned char” type. The available range of data values and the corresponding indicated signal levels are as shown in the table below.

This Data Value (Hexadecimal)	Indicates This Signal Level (Decimal)
0xFF	255
0xFE	254
•	•
•	•
•	•
0x01	1
0x00	0

7.3.2.6 Raw 12 Packed on Color Cameras (ID = 135)

When a color camera is set for the Raw 12 Packed color coding, it outputs 12 bits of data per pixel. Three bytes transmitted by the camera contains data for two pixels.

With the Raw 12 Packed coding, the pixel data is not processed or interpolated in any way. So, for each pixel covered with a red lens in the sensor's Bayer filter, you get 12 bits of red data. For each pixel covered with a green lens in the filter, you get 12 bits of green data. And for each pixel covered with a blue lens in the filter, you get 12 bits of blue data. (This type of pixel data is sometimes referred to as "raw" output.)

For more information about the Bayer filter, see Section 7.3 on page 127.

The tables below describe how the data for the even lines and for the odd lines of a received frame will be ordered in the image buffer in your PC when the camera is set for Raw 12 Packed output.

The following standards are used in the tables:

P_0 = the first pixel transmitted by the camera for a line

P_n = the last pixel transmitted by the camera a line

B_0 = the first byte of data for a line

B_m = the last byte of data for a line

Even Lines		
Byte	**Data**	
B_0	Blue value for P_0 bits 11 ... 4	
B_1	Green value for P_1 bits 3 ... 0	Blue value for P_0 bits 3 ... 0
B_2	Green value for P_1 bits 11 ... 4	
B_3	Blue value for P_2 bits 11 ... 4	
B_4	Green value for P_3 bits 3 ... 0	Blue value for P_2 bits 3 ... 0
B_5	Green value for P_3 bits 11 ... 4	
B_6	Blue value for P_4 bits 11 ... 4	
B_7	Green value for P_5 bits 3 ... 0	Blue value for P_4 bits 3 ... 0
B_8	Green value for P_5 bits 11 ... 4	
•	•	
•	•	•
•	•	
B_{m-5}	Blue value for P_{n-3} bits 11 ... 4	
B_{m-4}	Green value for P_{n-2} bits 3 ... 0	Blue value for P_{n-3} bits 3 ... 0
B_{m-3}	Green value for P_{n-2} bits 11 ... 4	
B_{m-2}	Blue value for P_{n-1} bits 11 ... 4	
B_{m-1}	Green value for P_n bits 3 ... 0	Blue value for P_{n-1} bits 3 ... 0
B_m	Green value for P_n bits 11 ... 4	

Odd Lines		
Byte	**Data**	
B_0	Green value for P_0 bits 11 ... 4	
B_1	Red value for P_1 bits 3 ... 0	Green value for P_0 bits 3 ... 0
B_2	Red value for P_1 bits 11 ... 4	
B_3	Green value for P_2 bits 11 ... 4	
B_4	Red value for P_3 bits 3 ... 0	Green value for P_2 bits 3 ... 0
B_5	Red value for P_3 bits 11 ... 4	
B_6	Green value for P_4 bits 11 ... 4	
B_7	Red value for P_5 bits 3 ... 0	Green value for P_4 bits 3 ... 0
B_8	Red value for P_5 bits 11 ... 4	
•	•	
•	•	•
•	•	
•	•	
•	•	•
•	•	
B_{m-5}	Green value for P_{n-3} bits 11 ... 4	
B_{m-4}	Red value for P_{n-2} bits 3 ... 0	Green value for P_{n-3} bits 3 ... 0
B_{m-3}	Red value for P_{n-2} bits 11 ... 4	
B_{m-2}	Green value for P_{n-1} bits 11 ... 4	
B_{m-1}	Red value for P_n bits 3 ... 0	Green value for P_{n-1} bits 3 ... 0
B_m	Red value for P_n bits 11 ... 4	

When a color camera is set for Raw 12 Packed, the pixel data output is 12 bit data of the “unsigned” type. The available range of data values and the corresponding indicated signal levels are as shown in the table below.

This Data Value (Hexadecimal)	**Indicates This Signal Level (Decimal)**
0x0FFF	4095
0x0FFE	4094
•	•
•	•
•	•
0x0001	1
0x0000	0

7.3.2.7 Raw 16 on Color Cameras (ID = 10)

When a color camera is set for the Raw 16 color code, it outputs 16 bits of data per pixel with 12 bits effective. The 12 bits of effective pixel data fill from the least significant bit. The four unused most significant bits are filled with zeros.

With the Raw 16 coding, the pixel data is not processed or interpolated in any way. So, for each pixel covered with a red lens in the sensor's Bayer filter, you get 12 effective bits of red data. For each pixel covered with a green lens in the filter, you get 12 effective bits of green data. And for each pixel covered with a blue lens in the filter, you get 12 effective bits of blue data. (This type of pixel data is sometimes referred to as "raw" output.)

For more information about the Bayer filter, see Section 7.3 on page 127.

The tables below describe how the data for the even lines and for the odd lines of a received frame will be ordered in the image buffer in your PC when the camera is set for Raw 16 output. Note that the data is placed in the image buffer in **little endian format**.

The following standards are used in the tables:

P_0 = the first pixel transmitted by the camera for a line

P_n = the last pixel transmitted by the camera a line

B_0 = the first byte of data for a line

B_m = the last byte of data for a line

Even Lines	
Byte	**Data**
B_0	Low byte of blue value for P_0
B_1	High byte of blue value for P_0
B_2	Low byte of green value for P_1
B_3	High byte of green value for P_1
B_4	Low byte of blue value for P_2
B_5	High byte of blue value for P_2
B_6	Low byte of green value for P_3
B_7	High byte of green value for P_3
•	•
•	•
•	•
B_{m-7}	Low byte of blue value for P_{n-3}
B_{m-6}	High byte of blue value for P_{n-3}
B_{m-5}	Low byte of green value for P_{n-2}
B_{m-4}	High byte of green value for P_{n-2}
B_{m-3}	Low byte of blue value for P_{n-1}
B_{m-2}	High byte of blue value for P_{n-1}
B_{m-1}	Low byte of green value for P_n
B_m	High byte of green value for P_n

Odd Lines	
Byte	**Data**
B_0	Low byte of green value for P_0
B_1	High byte of green value for P_0
B_2	Low byte of red value for P_1
B_3	High byte of red value for P_1
B_4	Low byte of green value for P_2
B_5	High byte of green value for P_2
B_6	Low byte of red value for P_3
B_7	High byte of red value for P_3
•	•
•	•
•	•
B_{m-7}	Low byte of green value for P_{n-3}
B_{m-6}	High byte of green value for P_{n-3}
B_{m-5}	Low byte of red value for P_{n-2}
B_{m-4}	High byte of red value for P_{n-2}
B_{m-3}	Low byte of green value for P_{n-1}
B_{m-2}	High byte of green value for P_{n-1}
B_{m-1}	Low byte of red value for P_n
B_m	High byte of red value for P_n

When a color camera is set for Raw 16, the pixel data output is 16 bit data of the “unsigned short (little endian)” type. The available range of data values and the corresponding indicated signal levels are as shown in the table below. Note that for 16 bit data, you might expect a value range from 0x0000 to 0xFFFF. With the camera set for Raw 16, however, only 12 bits of the 16 bits transmitted are effective. Therefore, the highest data value you will see is 0x0FFF indicating a signal level of 4095.

This Data Value (Hexadecimal)	**Indicates This Signal Level (Decimal)**
0x0FFF	4095
0x0FFE	4094
•	•
•	•
•	•
0x0001	1
0x0000	0

7.3.2.8 YUV 4:2:2 on Color Cameras (ID = 2)

When a color camera is set for the YUV 4:2:2 color coding, each pixel in the captured image goes through a two step conversion process as it exits the sensor and passes through the camera's electronics. This process yields Y, U, and V color information for each pixel.

In the first step of the process, an interpolation algorithm is performed to get full RGB data for each pixel. (Because each individual pixel gathers information for only one color, an interpolation must be made from the surrounding pixels to get full RGB data for an individual pixel.)

The second step of the process is to convert the RGB information to the YUV color model. The conversion algorithm uses the following formulas:

Y = 0.30 R + 0.59 G + 0.11 B

U = - 0.17 R - 0.33 G + 0.50 B

V = 0.50 R - 0.41 G - 0.09 B

Once the conversion to a YUV color model is complete, the pixel data is transmitted to the host PC. With this color coding a Y value is transmitted for each pixel, but the U and V values are only transmitted for every second pixel.

Note

The values for U and for V normally range from -128 to +127. Because the camera transmits U values and V values with unsigned integers, 128 is added to each U value and to each V value before the values are transmitted from the camera. This process allows the values to be transmitted on a scale that ranges from 0 to 255.

The table below describes how the pixel data for a received frame will be ordered in the image buffer in your PC when the camera is set for YUV 4:2:2 output.

The following standards are used in the table:

P_0 = the first pixel transmitted by the camera

P_n = the last pixel transmitted by the camera

B_0 = the first byte in the buffer

B_m = the last byte in the buffer

Byte	Data
B_0	U value for P_0
B_1	Y value for P_0
B_2	V value for P_0
B_3	Y value for P_1
B_4	U value for P_2
B_5	Y value for P_2
B_6	V value for P_2
B_7	Y value for P_3
B_8	U value for P_4
B_9	Y value for P_4
B_{10}	V value for P_4
B_{11}	Y value for P_5
•	•
•	•
•	•
B_{m-7}	U value for P_{n-3}
B_{m-6}	Y value for P_{n-3}
B_{m-5}	V value for P_{n-3}
B_{m-4}	Y value for P_{n-2}
B_{m-3}	U value for P_{n-1}
B_{m-2}	Y value for P_{n-1}
B_{m-1}	V value for P_{n-1}
B_m	Y value for P_n

Note

This byte order conforms to the DCAM standard for YUV 4:2:2 output.

When a color camera is set for YUV 4:2:2 output, the pixel data output for the Y component is 8 bit data of the “unsigned char” type. The range of data values for the Y component and the corresponding indicated signal levels are shown below.

This Data Value (Hexadecimal)	Indicates This Signal Level (Decimal)
0xFF	255
0xFE	254
•	•
•	•
•	•
0x01	1
0x00	0

The pixel data output for the U component or the V component is 8 bit data of the “straight binary” type. The range of data values for a U or a V component and the corresponding indicated signal levels are shown below.

This Data Value (Hexadecimal)	Indicates This Signal Level (Decimal)
0xFF	127
0xFE	126
•	•
•	•
•	•
0x81	1
0x80	0
0x7F	-1
•	•
•	•
•	•
0x01	-127
0x00	-128

The signal level of a U component or a V component can range from -128 to +127 (decimal). Notice that the data values have been arranged to represent the full signal level range.

7.3.2.9 YUV 4:2:2 (YUYV) on Color Cameras (ID = 133)

On color cameras, the YUV 4:2:2 (YUYV) color coding is similar to the YUV 4:2:2 color coding described in the previous section. The only difference is the order of the bytes transmitted to the host PC. With the YUV 4:2:2 coding, the bytes are ordered as specified in the DCAM standard. With the YUV 4:2:2 (YUYV) coding, the bytes are ordered to emulate the ordering normally associated with analog frame grabbers and Windows® frame buffers.

The table below describes how the pixel data for a received frame will be ordered in the image buffer in your PC when the camera is set for YUV 4:2:2 (YUYV) output.

With this color coding the Y component is transmitted for each pixel, but the U and V components are only transmitted for every second pixel.

The following standards are used in the table:

P_0 = the first pixel transmitted by the camera

P_n = the last pixel transmitted by the camera

B_0 = the first byte in the buffer

B_m = the last byte in the buffer

Byte	**Data**
B_0	Y value for P_0
B_1	U value for P_0
B_2	Y value for P_1
B_3	V value for P_0
B_4	Y value for P_2
B_5	U value for P_2
B_6	Y value for P_3
B_7	V value for P_2
B_8	Y value for P_4
B_9	U value for P_4
B_{10}	Y value for P_5
B_{11}	V value for P_4
•	•
•	•
•	•
B_{m-7}	Y value for P_{n-3}
B_{m-6}	U value for P_{n-3}
B_{m-5}	Y value for P_{n-2}
B_{m-4}	V value for P_{n-3}
B_{m-3}	Y value for P_{n-1}
B_{m-2}	U value for P_{n-1}
B_{m-1}	Y value for P_n
B_m	V value for P_{n-1}

When a color camera is set for YUV 4:2:2 (YUYV) output, the pixel data output for the Y component is 8 bit data of the “unsigned char” type. The range of data values for the Y component and the corresponding indicated signal levels are shown below.

This Data Value (Hexadecimal)	Indicates This Signal Level (Decimal)
0xFF	255
0xFE	254
•	•
•	•
•	•
0x01	1
0x00	0

The pixel data output for the U component or the V component is 8 bit data of the “straight binary” type. The range of data values for a U or a V component and the corresponding indicated signal levels are shown below.

This Data Value (Hexadecimal)	Indicates This Signal Level (Decimal)
0xFF	127
0xFE	126
•	•
•	•
•	•
0x81	1
0x80	0
0x7F	-1
•	•
•	•
•	•
0x01	-127
0x00	-128

The signal level of a U component or a V component can range from -128 to +127 (decimal). Notice that the data values have been arranged to represent the full signal level range.

7.3.2.10 YUV 4:2:2 on Monochrome Cameras (ID = 2)

When a monochrome camera is set for the YUV 4:2:2 color coding, the camera transmits Y, U, and V values in a fashion that mimics the output from a color camera set for YUV 4:2:2.

The Y value transmitted for each pixel is an actual 8 bit brightness value similar to the pixel data transmitted when a monochrome camera is set for Mono 8. The U and V values transmitted will always be zero. With this color coding, a Y value is transmitted for each pixel, but the U and V values are only transmitted for every second pixel.

The order of the pixel data for a received frame in the image buffer in your PC is similar to the order of YUV 4:2:2 output from a color camera.

7.3.2.11 YUV 4:2:2 (YUYV) on Monochrome Cameras (ID = 133)

When a monochrome camera is set for the YUV 4:2:2 (YUYV) color coding, the camera transmits Y, U, and V values in a fashion that mimics the output from a color camera set for YUV 4:2:2 (YUYV).

The Y value transmitted for each pixel is an actual 8 bit brightness value similar to the pixel data transmitted when a monochrome camera is set for Mono 8. The U and V values transmitted will always be zero. With this color coding, a Y value is transmitted for each pixel, but the U and V values are only transmitted for every second pixel.

The order of the pixel data for a received frame in the image buffer in your PC is similar to the order of YUV 4:2:2 (YUYV) output from a color camera.

7.4 Pixel Transmission Sequence

For each captured image, pixel data is transmitted from the camera in the following sequence:

$Row_0 Col_0$,	$Row_0 Col_1$,	$Row_0 Col_2$	.. ..	$Row_0 Col_{x-2}$,	$Row_0 Col_{x-1}$,	$Row_0 Col_x$
$Row_1 Col_0$,	$Row_1 Col_1$,	$Row_1 Col_2$	.. ..	$Row_1 Col_{x-2}$,	$Row_1 Col_{x-1}$,	$Row_1 Col_x$
$Row_2 Col_0$,	$Row_2 Col_1$,	$Row_2 Col_2$	.. ..	$Row_2 Col_{x-2}$,	$Row_2 Col_{x-1}$,	$Row_2 Col_x$
:	:	:		:	:	:
:	:	:		:	:	:
$Row_{y-2} Col_0$,	$Row_{y-2} Col_1$,	$Row_{y-2} Col_2$	.. ..	$Row_{y-2} Col_{x-2}$,	$Row_{y-2} Col_{x-1}$,	$Row_{y-2} Col_x$
$Row_{y-1} Col_0$,	$Row_{y-1} Col_1$,	$Row_{y-1} Col_2$	.. ..	$Row_{y-1} Col_{x-2}$,	$Row_{y-1} Col_{x-1}$,	$Row_{y-1} Col_x$
$Row_y Col_0$,	$Row_y Col_1$,	$Row_y Col_2$	.. ..	$Row_y Col_{x-2}$,	$Row_y Col_{x-1}$,	$Row_y Col_x$

Where:

- Col 0, Row 0 is the upper left corner of the sensor
- The columns are numbered 0 through x from the left side to the right side of the sensor
- The rows are numbered 0 through y from the top to the bottom of the sensor

The sequence assumes that the camera is set for full resolution.

Image data is transmitted as isochronous data packets. The first packet of each frame is identified by a one in the sync bit of the packet header.

8 Standard Features

This section provides detailed information about the standard features available on each camera. It also includes an explanation of the operation and the parameters associated with each feature.

8.1 Gain

The camera's gain setting is adjustable. As shown in Figure 56, increasing the gain increases the slope of the response curve for the camera. This results in a higher gray value output from the camera for a given amount of output from the imaging sensor. Decreasing the gain decreases the slope of the response curve and results in a lower gray value for a given amount of sensor output.

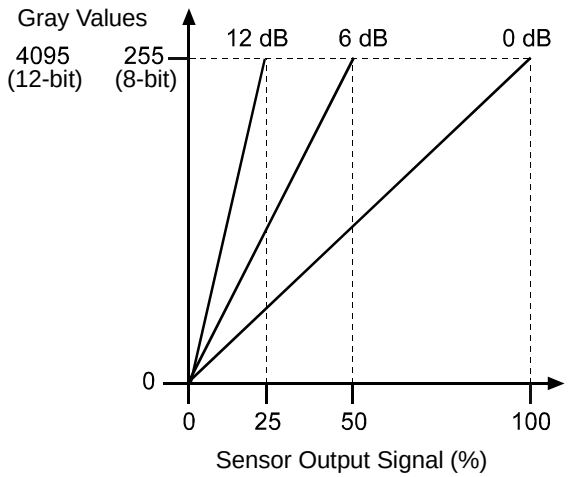


Fig. 56: Gain in dB

Increasing the gain is useful when at your brightest exposure, a gray value lower than 255 (in modes that output 8 bits per pixel) or 4095 (in modes that output 12 bits per pixels) is reached. For example, if you found that at your brightest exposure the gray values output by the camera were no higher than 127 (in an 8 bit mode), you could increase the gain to 6 dB (an amplification factor of 2) and thus reach gray values of 254.

Setting the Gain (All Models Except scA750-60)

Note

The information in this section applies to all camera models except the scA750-60 fm/fc. For information about scA750-60 cameras, see the next section.

The camera's gain is determined by the setting in the Value field of the camera's Gain control register. Gain is adjusted on a decimal scale. The minimum decimal setting varies depending on the camera model and on whether vertical binning is enabled (see Table 18). The maximum setting depends on whether the camera is set for a color coding that yields 8 bit effective pixel depth (Mono 8, Raw 8, YUV 4:2:2, YUV 4:2:2 (YUYV)) or yields an effective pixel depth of 12 bits per pixel (Mono 16, Raw 16).

.

Camera Model	Min Setting	Min Setting with Vertical Binning	Max Setting (8 bit depth)	Max Setting (16 bit depth)
scA640-70	320	260	1023	511
scA640-74	280	200	1023	511
scA780-54	350	280	1023	511
scA1000-20	330	260	1023	511
scA1000-30	360	280	1023	511
scA1300-32	300	200	850	400
scA1390-17	360	280	1023	511
scA1400-17	192	110	1023	511
scA1400-30	150	0	850	400
scA1600-14	350	280	1023	511

Table 18: Minimum and Maximum Allowed Gain Settings

For more information about color codings, see Section 7.3.2 on page 130.

For more information about the Gain control register, see page 270.

The Basler BCAM 1394 Driver includes a method call for setting the gain. For more information, see the online documentation delivered with the BCAM Driver.

If you know the current decimal setting for the value field in the Gain control register, you can use the formulas below to calculate the dB of gain that will result from that setting.

Calculation for the Models Except scA1400-30:

For gain raw settings from 110 to 511:

$$\text{Gain}_{dB} = 20 \times \log_{10}\left(\frac{658 + \text{Gain Setting}}{658 - \text{Gain Setting}}\right) - G_c$$

For gain raw settings from 512 to 1023:

$$\text{Gain}_{dB} = (0.0354 \times \text{Gain Setting}) - G_c$$

Where:

$$G_c = 20 \times \log_{10}\left(\frac{658 + \text{Min Gain Setting}}{658 - \text{Min Gain Setting}}\right)$$

Example:

Assume that you are working with a monochrome scA1400-17 camera that is set for the Mono 8 color coding and has a gain setting of 500. Calculating the gain is a two step process:

Step 1:

$$G_c = 20 \times \log_{10}\left(\frac{658 + 192}{658 - 192}\right)$$

$$G_c = 5.22 \text{ dB}$$

Step 2:

$$\text{Gain}_{dB} = 20 \times \log_{10}\left(\frac{658 + 500}{658 - 500}\right) - 5.22$$

$$\text{Gain}_{dB} = 12.1 \text{ dB}$$

Calculation for the scA1400-30:

For the entire range of raw settings:

$$\text{Gain}_{dB} = (0.0359 \times \text{Gain Raw Setting}) - 5.385 \text{ dB}$$

Table 19 shows the minimum and maximum gain in dB for each camera model.

Camera Model	dB Gain at Min Setting	dB Gain at Max Setting (8 bit depth)	dB Gain at Max Setting (16 bit depth)
scA640-70	0	27	8.8
scA640-74	0	28.3	10.1
scA780-54	0	25.9	7.7
scA1000-20	0	26.6	8.4
scA1000-30	0	25.5	7.3
scA1300-32	0	25.13	9.0
scA1390-17	0	25.5	7.3
scA1400-17	0	31.0	12.8
scA1400-30	0	25.13	9.0
scA1600-14	0	25.9	7.7

Table 19: Minimum and Maximum db of Gain

Setting the Gain (scA750-60 Only)

Note

The information in this section only applies to scA750-60 fm/fc cameras. For information about the other camera models, see the previous section.

The camera's gain is determined by the setting in the Value field of the camera's Gain control register. Gain is adjusted on a decimal scale. The range of settings for the Value field is from 0 to 22.

For more information about the Gain control register, see page 270.

The Basler BCAM 1394 Driver includes a method call for setting the gain. For more information, see the online documentation delivered with the BCAM Driver.

If you know the current decimal setting for the Value field in the Gain control register, you can use the following formula to calculate the dB of gain that will result from that setting:

$$\text{Gain}_{\text{dB}} = 20 \times \log_{10}\left(1 + \frac{\text{Gain Setting}}{6}\right)$$

Example:

Assume that you are working with an scA750-60 camera that has a gain raw setting of 18. The gain is calculated as follows:

$$\text{Gain}_{\text{dB}} = 12.0 \text{ dB}$$

Table 20 shows the dB of gain that will be achieved at various gain settings.

Gain Setting	dB Gain
0	0
5	5.3
10	8.5
15	10.9
20	12.7
22	13.4

Table 20: dB of Gain at Various Settings

8.2 Brightness

Adjusting the camera's brightness will result in an offset to the pixel values output by the camera. Increasing the brightness setting will result in a positive offset in the digital values output for the pixels. Decreasing the brightness setting will result in a negative offset in the digital values output for the pixels.

Effect on All Camera Models Except the scA750-60, scA1300-32, and scA1400-30

If the camera is set for a pixel data format that yields 8 bit effective pixel depth (Mono 8, Raw 8, YUV 4:2:2, YUV 4:2:2 (YUYV)), an increase of 16 in the brightness setting will result in a positive offset of 1 in the digital values output for the pixels. And a decrease of 16 in the setting will result in a negative offset of 1 in the digital values output for the pixels.

If the CCD camera is set for a pixel data format that yields an effective pixel depth of 12 bits per pixel (Mono 16, Raw 16), an increase of 1 in the brightness setting will result in a positive offset of 1 in the digital values output for the pixels. A decrease of 1 in the setting will result in a negative offset of 1 in the digital values output for the pixels.

Effect on scA750-60 Models

An increase of 4 in the brightness setting will result in a positive offset of 1 in the digital values output for the pixels. And a decrease of 4 in the setting will result in a negative offset of 1 in the digital values output for the pixels.

Effect on scA1300-32 and scA1400-30 Models

If the camera is set for a pixel data format that yields 8 bit effective pixel depth (Mono 8, Raw 8, YUV 4:2:2, YUV 4:2:2 (YUYV)), an increase of 64 in the brightness setting will result in a positive offset of 1 in the digital values output for the pixels. And a decrease of 64 in the setting will result in a negative offset of 1 in the digital values output for the pixels.

If the CCD camera is set for a pixel data format that yields an effective pixel depth of 12 bits per pixel (Mono 16, Raw 16), an increase of 4 in the brightness setting will result in a positive offset of 1 in the digital values output for the pixels. A decrease of 4 in the setting will result in a negative offset of 1 in the digital values output for the pixels.

Setting the Brightness

The camera's brightness is determined by the setting in the Value field of the camera's Brightness control register. The Value can range from 0 to 255 on all camera models except the scA750-60 gm/gc. On scA750-60 gm/gc cameras, the Value can range from 0 to 64. On scA1300-32fm/fc and scA1400-30fm/fc cameras, the Value can range from 0 to 1023.

For more information about color codings, see Section 7.3.2 on page 130.

For more information on the Brightness control register, see page 266.

The Basler BCAM 1394 Driver includes a method call for setting the brightness. For more information, see the online documentation delivered with the BCAM Driver.

8.3 White Balance (on Color Models)

White balance capability has been implemented on color models of the camera. White balancing can be used to adjust the color balance of the images transmitted from the camera when the camera is set for the YUV 4:2:2 or the YUV 4:2:2 (YUYV) color coding. With white balancing, correction factors are applied to the interpolated R, G, and B values that are used to calculate the Y, U, and V values for each pixel.

Setting the White Balance

The white balancing scheme outlined in the DCAM specification indicates that blue and red are adjustable and that green is not. Green normally has a fixed value.

The setting in the Blue Value field of the White Balance control register is used to change the blue correction factor. The usable range of settings for this field is from 0 to 255. If the field is set to 64, blue will have a 1.0 correction factor. If the field is set to a higher value, blue will have a higher correction factor and the image will be more blue. If the field is set to a value lower than 64, blue will have a correction factor lower than 1.0 and the maximum possible intensity for blue will decrease. For this reason, we don't normally recommend setting the field to a value lower than 64 unless you want to correct for a strong predominance of blue.

To determine the correction factor for blue, use this formula:

$$\text{Blue Correction Factor} = \frac{\text{Blue Value Setting}}{64}$$

The setting in the Red Value field of the White Balance control register is used to change the red correction factor. The usable range of settings for the this field is from 0 to 255. If the field is set to 64, red will have a 1.0 correction factor. If the field is set to a higher value, red will have a higher correction factor and the image will be more red. If the field is set to a value lower than 64, red will have a correction factor lower than 1.0 and the maximum possible intensity for red will decrease. For this reason, we don't normally recommend setting the field to a value lower than 64 unless you want to correct for a strong predominance of red.

To determine the correction factor for red, use this formula:

$$\text{Red Correction Factor} = \frac{\text{Red Value Setting}}{64}$$

Raising the correction factors for both blue and red will make your images appear less green. Lowering the correction factors for both blue and red will make your images appear more green.

For more information about the White Balance control register, see page 267.

The Basler BCAM 1394 Driver includes a method call for setting the white balance. For more information, see the online documentation delivered with the BCAM Driver.

Adjusting the Green Level

As mentioned above, the white balancing method outlined in the DCAM specification only includes provisions for changing the red level and the blue level. As a smart feature, color cameras also include the ability to adjust the green level.

For more information about the Green Level smart feature, see page 188.

8.4 Integrated IR Cut Filter (on Color Models)

Color models of the camera that have a C-mount lens adapter are equipped with an IR cut filter as standard equipment. The filter is mounted inside of the lens adapter. Cameras without an IR cut filter are available on request.

Color cameras that have the optional CS-mount lens adapter do not include an IR cut filter in the adapter.

Monochrome cameras do not include an IR cut filter in the lens adapter. Monochrome cameras with a C-mount lens adapter can be equipped with a filter on request.

CAUTION

Lens Thread Length is Limited

The location of the IR cut filter limits the length of the threads on any lens you use with the camera. If a lens with a very long thread length is used, the IR cut filter will be damaged or destroyed and the camera will no longer operate.

For more specific information about the location of the IR cut filter and about the lens thread length, see Section 1.5.3 on page 28.

8.5 Gamma Correction

The gamma correction feature lets you modify the brightness of the pixel values output by the camera's sensor to account for a non-linearity in the human perception of brightness. To accomplish the correction, a gamma correction factor (γ) is applied to the brightness value (Y) of each pixel according to the following formula:

$$Y_{corrected} = \left(\frac{Y_{uncorrected}}{Y_{max}}\right)^{\gamma} \times Y_{max}$$

The formula uses uncorrected and corrected pixel brightnesses that are normalized by the maximum pixel brightness. The maximum pixel brightness equals 255 for 8 bit output and 4095 for 12 bit output.

When the gamma correction factor is set to 1, the output pixel brightness will not be corrected.

A gamma correction factor between 0 and 1 will result in increased overall brightness, and a gamma correction factor greater than 1 will result in decreased overall brightness.

In all cases, black (output pixel brightness equals 0) and white (output pixel brightness equals 255 at 8 bit output and 4095 at 12 bit output) will not be corrected.

Setting Gamma Correction

The gamma correction factor is determined by the value in the Value field of the Gamma control register. The value in the field can range from 0 to 4095 on all camera models.

Note that the value in the Value field represents the product of the gamma correction factor and 1024. For example, a gamma correction factor of 1 requires a setting of 1024, a gamma correction factor of 2 requires a setting of 2048, and a gamma correction factor of 0.5 requires a setting of 512.

For more information on the Gamma control register, see Section 11.2.2 on page 266.

The Basler BCAM 1394 Driver does not include a method call to access the gamma register. As a work around, you can use the Basler Smart Features Framework software to directly read from or write to the register. For more information about the Smart Features Framework software, see Section 9.2 on page 169.

8.6 Strobe Control Output Signals

The cameras include a feature designed to help you control strobe lighting. The feature allows a user to enable and parameterize up to four strobe control output signals. The signals are designated as Strobe 0, Strobe 1, Strobe 2, and Strobe 3. The camera's Strobe Signal control registers are used to enable and parameterize the strobe output signals.

The text below describes using the Strobe Signal control registers for Strobe 0 to enable and parameterize Strobe 0. Strobe 1, Strobe 2 and Strobe 3 are enabled and parameterized in similar fashion by using the respective registers for each strobe.

For more information about the Strobe control registers, see page 285.

Enabling the Strobe 0 Control Feature

To enable the Strobe 0 signal:

- Set the value in the On/Off field of the Strobe 0 Control register to 1.

Setting the Delay for Strobe 0

The strobe delay is defined as the time between the start of image exposure and the point where the strobe signal rises as shown in Figure 57.

The strobe delay is determined by a combination of two values. The first is the setting in the Delay Value field of the Strobe 0 Control register. The second is the Strobe Delay Time Base. The Strobe 0 delay will be determined by the product of these two values:

Strobe 0 Delay = (Strobe 0 Delay Value Setting) x (Strobe Delay Time Base)

The strobe delay time base is fixed at 1 µs by default. Strobe 0 delay time is normally adjusted by changing the setting in the Delay Value field of the Strobe 0 Control register. The delay value setting can range from 0 to 4095. So if the setting in the Delay Value field of the Strobe 0 Control register is set to 100, for example, the Strobe 0 delay will be 100 µs.

As mentioned above, the strobe delay time base is normally fixed at 1 µs and the Strobe 0 delay is normally adjusted by changing the delay value setting only. However, if you require a delay that is longer than what you can achieve by changing the strobe delay value alone, the strobe delay time base value can also be changed. The Strobe Delay Time Base smart feature can be used to change the strobe delay time base.

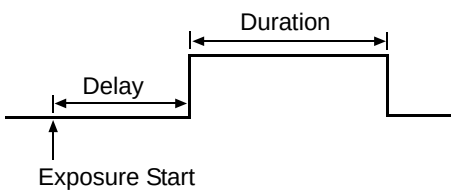


Fig. 57: Strobe Signal

For more information about the Strobe Delay Time Base smart feature, see Section 9.6.9 on page 222.

Setting the Duration for Strobe 0

The strobe duration is determined by a combination of two values. The first is the setting in the Duration Value field of the Strobe 0 Control register. The second is the Strobe Duration Time Base. Strobe 0 duration will be determined by the product of these two values:

Strobe 0 Duration = (Strobe 0 Duration Value Setting) x (Strobe Duration Time Base)

The strobe duration time base is fixed at 1 µs by default. Strobe 0 duration is normally adjusted by changing the setting in the Duration Value field of the Strobe 0 Control register. The duration value setting can range from 0 to 4095. So if the setting in the Duration Value field of the Strobe 0 Control register is set to 250, for example, the Strobe 0 duration will be 250 µs.

As mentioned above, the strobe duration time base is normally fixed at 1 µs and the Strobe 0 duration is normally adjusted by changing the duration value setting only. However, if you require a duration that is longer than what you can achieve by changing the strobe duration value alone, the strobe duration time base can also be changed. The Strobe Duration Time Base smart feature can be used to change the strobe duration time base.

For more information about the Strobe Time Base smart feature, see Section 9.6.9 on page 222.

Assigning the Strobe 0 Signal to a Port

Once the Strobe 0 output signal has been enabled and parameterized, **it must be assigned to a physical output port on the camera**. The Strobe 0 signal can only be assigned to physical output port 0. Strobe output signals are assigned to physical ports by using the Output Port Configuration smart feature.

If you enable the Strobe 1, Strobe 2 and Strobe 3 output signals, you must also use the Output Port Configuration smart feature to assign these signals to physical output ports on the camera. The Strobe 1 signal can only be assigned to physical output port 1. The Strobe 2 signal can only be assigned to physical output port 2. The Strobe 3 signal can only be assigned to physical output port 3.

Once you have assigned a strobe signal to an output port, you can also use the Output Port Configuration feature to invert the strobe output signal.

For more information about the Output Port Configuration smart feature, see Section 9.6.7 on page 216.

For more information about the output port electrical characteristics, see Section 4.7.2 on page 78

Note

If you start an image exposure and the strobe signal for the previously captured image is still running, the running strobe signal ends immediately and the next delay and duration begin.

The Basler BCAM 1394 Driver does not include a method call to access the Strobe control registers. As a work around, you can use the Basler Smart Features Framework software to directly read from or write to the registers. For more information about the Smart Features Framework software, see Section 9.2 on page 169.

8.7 Parallel I/O Control

A parallel I/O control feature is available on the cameras. This feature lets a user set the state of the four physical output ports on the camera and to read the state of the two physical input ports.

- To set state of the four physical output ports, write values to the fields in the PIO Control registers:
- The value in the Port 0 Out field of the output register sets the state of physical output port 0.
- The value in the Port 1 Out field of the output register sets the state of physical output port 1.
- The value in the Port 2 Out field of the output register sets the state of physical output port 2.
- The value in the Port 3 Out field of the output register sets the state of physical output port 3.

Writing to the PIO Output register will only set the state of physical output ports that are configured as “user set.” For any output ports not configured as user set, the bit settings in this register will be ignored.

To determine the current state of the two physical input ports, read the contents of the PIO Input register:

- The value in the Port 0 In field of the input register indicates the current state of physical input port 0.
- The value in the Port 1 In field of the input register indicates the current state of physical input port 1.

For more information about the PIO control registers, see page 281.

For more information about configuring output ports as "user set", Section 9.6.7 on page 216.

The Basler BCAM 1394 Driver does not include a method call to access the Parallel I/O control registers. As a work around, you can use the Basler Smart Features Framework software to directly read from or write to the registers. For more information about the Smart Features Framework software, see Section 9.2 on page 169.

8.8 Configuration Sets and Memory Channels

A configuration set is a group of values that contains all of the parameter settings needed to control the camera. There are three basic types of configuration sets: the active configuration set, the default configuration set, and user configurations sets.

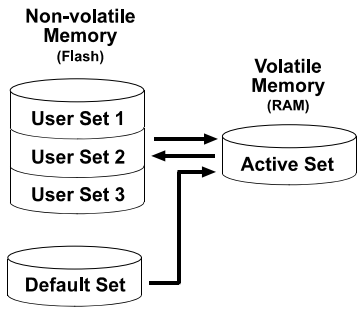


Fig. 58: Configuration Sets

Active Configuration Set

The active configuration set contains the camera's current parameter settings and thus determines the camera's performance, that is, what your image currently looks like. When you change parameter settings using the BCAM API or the BCAM Viewer, you are making changes to the active configuration set. The active configuration set is located in the camera's volatile memory and the settings are lost if the camera is reset or if power is switched off. The active configuration set is usually called the "active set" for short.

Default Configuration Set

When a camera is manufactured, a test setup is performed on the camera and an optimized configuration is determined. The default configuration set contains the camera's factory optimized configuration. The default configuration set is saved in a permanent file in the camera's non-volatile memory. It is not lost when the camera is reset or switched off and it cannot be changed. The default configuration set is usually just called the "default set" for short.

User Configuration Sets

As mentioned above, the active configuration set is stored in the camera's volatile memory and the settings are lost if the camera is reset or if power is switched off. The camera can save most of the settings from the current active set to a reserved area in the camera's non-volatile memory called a memory channel. A configuration set saved in a memory channel is not lost when the camera is reset or switched off. There are three memory channels in the camera's non-volatile memory available for saving configuration sets: memory channel 1, memory channel 2, and memory

channel 3. A configuration set saved in a memory channel is commonly referred to as a "user configuration set" or "user set" for short.

Note

The ability to use memory channels to save configuration sets is only available when the camera is set for format 7.

The settings for the lookup table are not saved in the user sets and are lost when the camera is reset or switched off. If used, these settings must be set again after each camera reset or restart.

Startup Set

You can select the default set or one of the user configuration sets stored in the memory channels to be loaded into the active set when the camera starts up after power on or after a reset. Instructions for selecting the startup configuration set appear on the next page.

8.8.1 Saving Configuration Sets

Saving the current active set into a memory channel is a three step process:

- Make changes to the camera's settings until the camera is operating in a manner that you would like to save.
- Set the value of the Memory Save Channel control register to 1, 2, or 3. This will select the memory channel where the configuration set will be saved.
- Set the value of the Memory Save control register to 1. When you set this value to 1, the camera will save the current parameter settings to the designated memory channel.

Saving an active set into a memory channel will overwrite any user set that was previously saved in that memory channel.

For more information about the Memory Save Channel control register, see page 263.

For more information about the Memory Save control register, see page 263.

The Basler BCAM 1394 Driver does not include a method call to access the Memory Channel or Memory Save control registers. As a work around, you can use the Basler Smart Features Framework software to directly read from or write to the registers. For more information about the Smart Features Framework software, see Section 9.2 on page 169.

8.8.2 Loading a Saved Set ot the Default Set into the Active Set

If you have saved one or more user configuration sets into the memory channels, you can load a saved user set from a memory channel into the camera's active set. When you do this, the loaded set overwrites the parameters in the active set. Since the settings in the active set control the current operation of the camera, the settings from the loaded set will now be controlling the camera.

On all cameras, the default set is stored in a reserved memory channel designated as memory channel 0. Memory channel 0 is protected and the default set stored in memory channel 0 can't be altered in any way. You can also load the default set into the camera's active set.

To load a saved user configuration set or the default set from a memory channel into the active set:

- Set the value of the Current Memory Channel control register to 0, 1, 2, or 3 as desired. When you set the value in the register, the parameter settings will be copied from the designated memory channel into the active set.

Note

Loading a user set or the default set into the active set is only allowed when the camera is idle, i.e. when it is not acquiring images continuously or does not have a single image acquisition pending.

Loading the default set into the active set is a good course of action if you have grossly misadjusted the settings in the camera and you are not sure how to recover. The default settings are optimized for use in typical situations and will provide good camera performance in most cases.

For more information about the Current Memory Channel control register, see page 264.

The Basler BCAM 1394 Driver does not include a method call to access the Current Memory Channel control registers. As a work around, you can use the Basler Smart Features Framework software to directly read from or write to the registers. For more information about the Smart Features Framework software, see Section 9.2 on page 169.

8.8.3 Selecting a Startup Set

Whenever a camera starts up at power on or after a reset, by default, it loads the default set stored in memory channel 0 into the active set. The camera has a "startup channel" feature that lets you change this behavior. The startup channel feature designates the memory channel to be used at startup. For example, if the startup channel is designated as memory channel 2, the user set stored in memory channel 2 will be loaded into the active set at power on or reset.

The startup memory channel feature has been implemented as a smart feature. For more information about the startup memory channel smart feature, see Section 9.6.12 on page 227.

9 Smart Features

This section provides detailed information about the smart features available on each camera.

9.1 Smart Features Basics

Smart features are features unique to Basler cameras. Test Images, the Frame Counter, and the CRC (Cyclic Redundancy Check) Checksum are examples of Basler smart features.

In some cases, enabling a smart feature will simply change the behavior of the camera. The Test Image feature is a good example of this type of smart feature. When the Test Image feature is enabled, the camera outputs a test image rather than a captured image. This type of smart feature is referred to as a “non-reporting” smart feature.

When certain smart features are enabled, the camera actually develops some sort of information about each image that it captures. In these cases, the information is added to each image as trailing data when the image is transferred from the camera to your host PC. Examples of this type of smart feature are the Frame Counter feature and the CRC Checksum. When the Frame Counter feature is enabled, for example, the camera checks a counter that tracks the number of images captured and develops a frame counter stamp for each image. The stamp is added to each image as trailing data when the image is transmitted.Features that add data to the acquired images are referred to as “reporting” smart features.

9.2 The Smart Features Framework

The Smart Features Framework (SFF) is a mechanism that allows you to enable and parametrize smart features. This mechanism is essentially an extension of the register structure defined in the DCAM specification for use with “Advanced Features.” The SFF establishes a register for each smart feature. By setting bits within the register for a particular smart feature, you can enable the feature and control how the feature operates.

The SFF also provides a mechanism for parsing the trailing data added to images transmitted out of the camera by reporting smart features. Whenever the camera adds data for a smart feature to an image, it includes a unique identifier (a GUID) for the smart feature as part of the added data. The GUIDs are especially useful when you enable several reporting smart features. The GUIDs make it possible to identify which portion of the added data is the result of each enabled reporting feature.

9.2.1 Smart Features Framework Software

The Smart Features Framework Software (SFF Software) package is available from Basler. The SFF Software has two major components:

- An SFF Viewer. The viewer is a Windows® based tool that allows you to easily enable and disable smart features, parameterize the camera, capture and view images, and view smart features results.
- An SFF Tutorial. The tutorial explains how to access the register structure for the camera's smart features from within your own applications. The tutorial is based on the assumption that you are using the Basler BCAM 1394 Driver with your camera.

The SFF software package is available for download at the Basler web site.

9.3 Requirements for Using Smart Features

To use smart features you will need:

- A camera that supports smart features.
- A method of accessing the camera's DCAM register structure. We strongly recommend that you use the Basler BCAM 1394 Driver (v1.9 or higher) along with the Basler Smart Features Framework software to access the registers.

Note

We strongly recommend that you use the Basler BCAM 1394 Driver. However, any driver that can get images in format 7 and that provides access to the DCAM registers can be used to work with smart features. If you do use a different driver, you can adapt the access techniques described in the SFF Software tutorial to the driver you are using.

You should be aware that drivers other than the Basler BCAM 1394 Driver have not been tested with smart features.

9.4 Enabling and Parameterizing a Smart Feature

The camera provides a control and status register (CSR) for each smart feature. To enable and parameterize a smart feature, the following steps must be performed:

1. Check to see if the camera supports smart features.
2. Ask the camera for the address of the CSR for the desired smart feature.
3. Enable and parameterize the desired smart features.

The next three sections describe these steps.

9.4.1 Checking to see if Smart Features are Supported

Smart features are vendor unique. Such features are referred to in the 1394 Trade Association DCAM standard as advanced features. The DCAM standard specifies how vendors should implement advanced features. According to the standard, advanced features capability must be unlocked by writing an advanced features set identifier (Feature ID) and a time-out value to the camera's Advanced Features Access Control Register (ACR). The Feature ID associated with Basler smart features is 0x0030 533B 73C3. From the point of view of the DCAM standard, smart features are a set of advanced DCAM features.

For Basler cameras, unlocking advanced features is not strictly necessary because all implemented smart features are always available. However, the unlock mechanism is also used to check to see if a camera supports vendor unique features such as smart features. If a device doesn't recognize a Feature ID written to the ACR, a value of 0xFFFF FFFF FFFF FFFF will be read back from the ACR. This value indicates that the device does not implement the feature set associated with that Feature ID.

Assuming that the address of the Advanced Features ACR is 0xFFFF F2F0 0000, perform the following steps to see if a camera is smart features capable:

1. Write the quadlet data 0x0030 533B to 0xFFFF F2F0 0000
2. Write quadlet data 0x73C3 F000* to 0xFFFF F2F0 0004
3. Read quadlet data from 0xFFFF F2F0 0000 and 0xFFFF F2F0 0004. If at least one of the read operations returns a value that is not equal to 0xFFFF FFFF, the camera supports smart features. If both read operations return 0xFFFF FFFF, the camera does not support smart features.

Note that instead of performing two single quadlet write operations, a block write can be performed.

* The last three zeros in this quadlet represent a timeout value. When the timeout value is "000", it means that advanced features are always available.

9.4.2 Determining the CSR Address for a Smart Feature

The control and status register (CSR) for each smart feature is identified by a 128 bit Globally Unique Identifier (GUID). GUIDs are also known as UUIDs (Universal Unique Identifier).

A GUID consists of:

- One 32 bit number (D1)
- Two 16 bit numbers (D2, D3)
- A sequence of 8 bytes (D4[0] - D4[7])

GUID example:

CA8A916A - 14A4 - 4D8E - BBC9 - 93DF50495C16

(D1) (D2) (D3) (D4[0] - D4[1]) (D4[2] - D4[7])

Detailed descriptions of the camera's available smart features appear later in the Smart Features section of this manual. You will notice that each description includes the GUID assigned to the smart feature's CSR.

To determine the starting address of a smart feature's CSR, the CSR GUID must be written to the Smart Features Inquiry register. The Smart Features Inquiry register's offset relative to the Advanced Features Access Control Register is 0x10. If the camera recognizes the GUID as the CSR GUID for an implemented smart feature, the address of CSR for the feature can be read from the Smart Features Address Register at offset 0x20. If the feature isn't supported by the device, a value of 0x0 will be read from the Smart Features Address Register.

Smart Features Inquiry Register Layout

	Bit			
Offset	0-7	8-15	16-23	24-31
10h	D1			
14h	D3		D2	
18h	D4[3]	D4[2]	D4[1]	D4[0]
1ch	D4[7]	D4[6]	D4[5]	D4[4]

Smart Features Address Register Layout

	Bit			
Offset	0-7	8-15	16-23	24-31
20h	Address Low			
24h	Address High			

Example

Determine the address for a smart feature which has a CSR GUID of:

3B34004E - 1B84 - 11D8 - 83B3 - 00105A5BAE55

D1:0x3B34 004E

D2:0x1B84

D3:0x11D8

D4[0]:0x83

D4[1]:0xB3

D4[2]:0x00

D4[3]:0x10

D4[4]:0x5A

D4[5]:0x5B

D4[6]:0xAE

D4[7]:0x55

Step 1: Write the CSR GUID to the Smart Features Inquiry Register

Assuming that the address for the Access Control Register is 0xFFFF F2F0 0000, perform the following quadlet write operations to the Smart Features Inquiry Register

- Write quadlet data 0x3B34 004E to 0xFFFF F2F0 0010(D1)
- Write quadlet data 0x11D8 1B84 to 0xFFFF F2F0 0014(D3 | D2)
- Write quadlet data 0x1000 B383 to 0xFFFF F2F0 0018(D4[3] | D[0])
- Write quadlet data 0x55AE 5B5A to 0xFFFF F2F0 001C(D4[7] | D[4])

Instead of performing four quadlet write operations, one block write operation can be performed.

Step 2: Read the start address for the smart feature from the Smart Features Address Register

- Read quadlet data from 0xFFFF F2F0 0020 (Address Low)
- Read quadlet data from 0xFFFF F2F0 0024 (Address High)

If both Address Low and Address High return zero, the camera doesn’t support the feature. Assuming the read operations yielded Address Low = 0xF2F0 0038 and Address High = 0x0000 FFFF, the address for the feature’s CSR is 0xFFFF F2F0 0038.

9.4.3 Enabling and Parameterizing a Feature

Once you have determined the starting address of the control and status register (CSR) for your desired smart feature, you are ready to enable and parameterize the feature by setting bits within the CSR.

The remainder of the Smart Features section contains detailed descriptions of the smart features available on the camera. Each description includes an explanation of what the feature does and an explanation of the parameters associated with the feature. The descriptions also include a detailed layout of how the bits contained within the feature's CSR relate to the parameters for the feature. After reading the description of your desired smart feature, you can enable and parameterize the feature by setting the appropriate bits within the CSR.

9.5 Reporting Smart Features

9.5.1 Getting Reporting Smart Features Results

Activating a reporting smart feature results in additional data that must be transmitted by the camera, i.e., the results of the reporting feature. The results of a reporting feature will be appended to the image data so that each frame contains both image data and reporting features results.

Before you can use any of the reporting features, the extended data stream feature must be enabled. The extended data stream is in itself a reporting feature. When the extended data stream feature is enabled, information such as the height of the image, the width of the image, and the AOI size is added to each captured image's basic pixel data. Disabling the extended data stream feature switches off all reporting features.

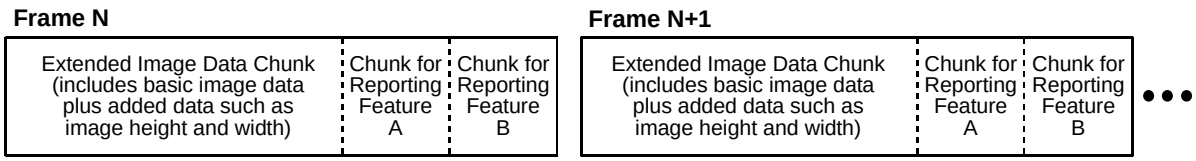

Frame N
Extended Image Data Chunk (includes basic image data plus added data such as image height and width)
Chunk for Reporting Feature A
Chunk for Reporting Feature B
Frame N+1
Extended Image Data Chunk (includes basic image data plus added data such as image height and width)
Chunk for Reporting Feature A
Chunk for Reporting Feature B

Fig. 59: Image Data Stream with Reporting Features Enabled

As illustrated in Figure 59, when any of the reporting features are enabled, each image frame consists of "chunks." For example, the frame may include a chunk which contains the extended image data (the basic image data plus the added height, width, etc. information), a chunk which contains the results for the frame counter feature, a chunk which contains the results for the CRC checksum feature, etc. Table 21 describes the general structure of a chunk.

Position	Name	Description
0	Data [K Bytes]	The data that the chunk is transporting
K	Chunk GUID [16 Bytes]	Identifies the type of chunk and the feature associated with the chunk
K+16	Length [4 Bytes]	The chunk's total length in bytes
K+20	Inverted Length [4 Bytes]	The bitwise complement of the length

Table 21: General Structure of a Chunk

Each chunk ends with a four byte unsigned integer indicating the length of the chunk and four bytes which indicate the bitwise complement of the length. Transferring both the chunk length and the bitwise complement of the length serves as a mechanism to detect transmission errors. If the last

four bytes of a chunk aren't the bitwise complement of the preceding four bytes, the chunk's length information isn't valid and this indicates that a transmission error occurred.

Although most chunks follow the general structure described in Table 21, each type of chunk has unique aspects to its layout. To let you distinguish between the chunks, each chunk carries a "chunk GUID". The GUID for each chunk is transferred just before the chunk's length information. If you look through the descriptions of the reporting features in this manual, you will notice that for features which add a chunk to the image data stream, there is a description of the layout of the chunk and the chunk GUID associated with the chunk.

A chunk's length field contains the chunk's total length in bytes. The GUID, the length, and the inverted length are included as part of the total chunk length.

By appending length information and a chunk GUID to each chunk, the camera sends a self-describing data stream and allows easy navigation through the individual chunks that make up a complete image data frame. Because the added chunk for each feature contains a unique GUID and the chunk layout includes the GUID and chunk length information as described above, you can parse the chunks in the transferred frame by starting at the end of the data and working backward.

Notes

Don't confuse chunk GUIDs with CSR GUIDs:

- Each reporting smart feature has a unique "chunk GUID" assigned to the feature. The chunk GUID will be included in the chunk of data that the reporting smart feature adds to the image data. The chunk GUIDs help you to determine which reporting feature is associated with each chunk added to the image data.
- Every smart feature, both reporting and non-reporting, has a control and status register (CSR) associated with it. Each CSR has a unique CSR GUID assigned to it. The CSR GUIDs help you to identify which CSR is associated with each smart feature.

9.5.1.1 Buffer Size Needed with Reporting Features Enabled

When reporting smart features are enabled, the size of each transmitted frame will be larger than a frame that contains only image data. To determine the size of the buffer that you will need in your host PC to hold an image with appended smart features data, check the Total Bytes High Inquiry and Total Bytes Low Inquiry registers of the Format 7 mode you are currently using. Make sure to check these registers after all desired smart features have been enabled and all other settings affecting the image size have been completed. The size information in these inquiry registers will let you properly set up buffers to receive the transmitted images.

9.5.2 Extended Data Stream

The extended data stream feature has two functions:

- When it is enabled, information such as image height, image width, and AOI size is added to the basic pixel data for each image.
- It must be enabled before you can use any other smart feature that adds information to the image data stream.

With the extended data stream feature enabled, the basic pixel data for each image and the added information such as the image height and width are included in an “extended data chunk.” Refer to the extended data chunk layout below for a complete description of the information included in the extended data chunk.

Note

The extended data stream feature must be enabled before you can use any of the other reporting smart feature. Disabling the extended data stream feature disables all other reporting smart features.

The extended data stream feature and all other reporting smart features will only work when the camera is set for video format 7.

Control and Status Register for the Extended Data Stream Feature

Name	Extended Data Stream	
Address	See “Determining the Address of Smart Features CSRs” earlier in this section	
CSR GUID	4E7ABCB0 - 1B84 - 11D8 - 9651 - 00105A5BAE55	
Field	**Bit**	**Description**
Presence Inq (Read only)	[0]	Presence of the extended data stream feature on the camera: 0 = not present 1 = present
----	[1 ... 30]	Reserved
Enable (Read / write)	[31]	Enable / disable this feature: 0 = disable 1 = enable

Extended Data Chunk Layout

Position	Name	Description
0	Pixel Data [K Bytes]	The pixel data from the captured image
K	Gap [M Bytes]	For technical reasons, there might be a gap between the pixel data and the other data in the extended image data
K + M	Stride [4 Bytes]	Signed integer. Indicates the number of bytes needed to advance from the beginning of one row in an image to the beginning of the next row.
K + M + 4	Reserved [3 Bytes]	-----
K + M + 7	Data Depth [1 Byte]	Effective data depth in bits of the pixels in the image
K + M + 8	Top [2 Bytes]	Y coordinate of the top left corner of the current area of interest (AOI)
K + M + 10	Left [2 Bytes]	X coordinate of the top left corner of the current AOI
K + M + 12	Height [2 Bytes]	Height in pixels of the current AOI
K + M + 14	Width [2 Bytes]	Width in pixels of the current AOI
K + M + 16	Reserved [3 Bytes]	-----
K + M + 19	Color Coding ID [1 Byte]	Color coding ID
K + M + 20	Reserved [3 Bytes]	-----
K + M + 23	Color Filter ID [1 Byte]	For color cameras, describes the alignment of the Bayer color filter to the current AOI
K + M + 24	Chunk GUID [16 Bytes]	94ED7C88 - 1C0F - 11D8 - 82E0 - 00105A5BAE55
K + M + 40	Chunk Length [4 Bytes]	This chunk’s total length in bytes
K + M + 44	Inverted Chunk Length [4 Bytes]	The bitwise complement of the chunk length

9.5.3 Frame Counter Stamp

The frame counter stamp feature numbers images sequentially as they are captured. When the feature is enabled, a chunk is added to each image containing the value of the counter.

The counter starts at 0 and wraps at 4294967296 (operating continuously at 100 frames per second, it would take the counter about 500 days to wrap). The counter increments by one for each captured frame. Whenever the camera is powered off, the counter will reset to 0.

Be aware that if the camera is capturing images continuously and continuous capture is stopped, several numbers in the counting sequence may be skipped. This happens due to the internal image buffering scheme used in the camera.

Note

The extended data stream feature must be enabled before you can use the frame counter feature or any of the other reporting smart feature. Disabling the extended data stream feature disables all other reporting smart features.

The frame counter feature and all other reporting smart features will only work when the camera is set for video format 7.

Control and Status Register for the Frame Counter Stamp Feature

Name	Frame Counter Stamp	
Address	See “Determining the Address of Smart Features CSRs” earlier in this section.	
CSR GUID	4433C4A4 - 1B84 - 11D8 - 86B2 - 00105A5BAE55	
Field	**Bit**	**Description**
Presence Inq (Read only)	[0]	Presence of the frame counter stamp feature on the camera: 0 = not present 1 = present
----	[1 ... 30]	Reserved
Enable (Read / write)	[31]	Enable / disable this feature: 0 = disable 1 = enable

Frame Counter Stamp Chunk Layout

Position	Name	Description
0	Counter [4 Bytes]	The frame counter.
4	Chunk GUID [16 Bytes]	8C5DB844 - 1C0F - 11D8 - 965F - 00105A5BAE55
20	Chunk Length [4 bytes]	This chunk's total length in bytes
24	Inverted Chunk Length [4 bytes]	The bitwise complement of the chunk length

9.5.4 Cycle Time Stamp

The cycle time stamp feature adds a chunk to each image frame containing the value of the counters for the IEEE 1394 bus cycle timer. The counters when the camera receives a trigger signal.

Note

The extended data stream feature must be enabled before you can use the cycle time stamp feature or any of the other reporting smart feature. Disabling the extended data stream feature disables all other reporting smart features.

The cycle time stamp feature and all other reporting smart features will only work when the camera is set for video format 7.

Control and Status Register for the Cycle Time Stamp Feature

Name	Cycle Time Stamp	
Address	See “Determining the Address of Smart Features CSRs” earlier in this section	
CSR GUID	5590D58E - 1B84 - 11D8 - 8447 - 00105A5BAE55	
Field	**Bit**	**Description**
Presence Inq (Read only)	[0]	Presence of the cycle time stamp feature on the camera: 0 = not present 1 = present
----	[1 ... 30]	Reserved
Enable (Read / write)	[31]	Enable / disable this feature: 0 = disable 1 = enable

Cycle Time Stamp Chunk Layout

Position	Name	Description		
0	Cycle Time Stamp [4 Bytes]	**Field**	**Bit**	**Description**
		Second Count	[0 ... 6]	Counts the seconds. Wraps to zero after 127 seconds.
		Cycle Count	[7 ... 19]	Counts the 125 µs isochronous bus cycles. Wraps to zero after counting to 7999.
		Cycle Offset	[20 ... 31]	Counts at 24.576 MHz and wraps to zero after counting to 3071 (resulting in a 125 µs cycle)
4	Chunk GUID [16 Bytes]	994DD430 - 1C0F - 11D8 - 8F6B - 00105A5BAE55		
20	Chunk Length [4 Bytes]	This chunk’s total length in bytes		
24	Inverted Chunk Length [4 Bytes]	The bitwise complement of the chunk length		

9.5.5 I/O State Stamp

The I/O state stamp feature adds a chunk to each image frame containing the state of the camera's input ports and output ports. The states are sampled when the camera receives a trigger signal.

Note

The extended data stream feature must be enabled before you can use the I/O state stamp feature or any of the other reporting smart feature. Disabling the extended data stream feature disables all other reporting smart features.

The I/O state stamp feature and all other reporting smart features will only work when the camera is set for video format 7.

Control and Status Register for the I/O State Stamp Feature

Name	I/O State Stamp	
Address	See "Determining the Address of Smart Features CSRs" earlier in this section	
CSR GUID	19141296 - D1D2 - 11D9 - 99F2 - 0030535BAE55	
Field	**Bit**	**Description**
Presence Inq (Read only)	[0]	Presence of the I/O states feature on the camera: 0 = not present 1 = present
----	[1 ... 30]	Reserved
Enable (Read / write)	[31]	Enable / disable this feature: 0 = disable 1 = enable

I/O State Stamp Chunk Layout

Position	Name	Description		
0	I/O States [4 Bytes]	**Field**	**Bit**	**Description**
		In_0	0	State of input 0
		In_1	1	State of input 1
		-----	[2 ... 15]	Reserved
		Out_0	16	State of output 0
		Out_1	17	State of output 1
		Out_2	18	State of output 2
		Out_3	18	State of output 3
		-----	[19 ... 31]	Reserved
4	Chunk GUID [16 Bytes]	52FCBF4E - D1D2 - 11D9 - 8291 - 0030535BAE55		
20	Chunk Length [4 Bytes]	This chunk’s total length in bytes		
24	Inverted Chunk Length [4 Bytes]	The bitwise complement of the chunk length		

9.5.6 CRC Checksum

The CRC (Cyclic Redundancy Check) Checksum feature adds a chunk to each image frame containing a 16 bit CRC checksum calculated using the Z-modem method. The CRC checksum chunk is always the last chunk added to the image data stream and the chunk is always 32 bits in size. As shown in Figure 60, the checksum is calculated using all of the image data and all of the appended chunks except for the checksum itself.

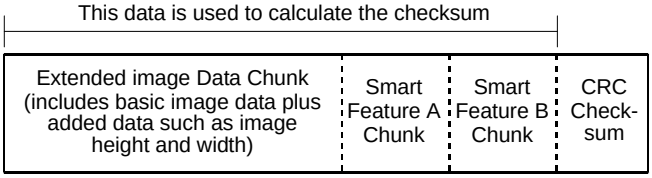

This data is used to calculate the checksum
Extended image Data Chunk (includes basic image data plus added data such as image height and width)
Smart Feature A Chunk
Smart Feature B Chunk
CRC Check-sum

Fig. 60: Data Used for the Checksum Calculation

Note

The extended data stream feature must be enabled before you can use the CRC checksum feature or any of the other reporting smart feature. Disabling the extended data stream feature disables all other reporting smart features.

The CRC checksum feature and all other reporting smart features will only work when the camera is set for video format 7.

Control and Status Register for the CRC Checksum Feature

Name	CRC Checksum	
Address	See “Determining the Address of Smart Features CSRs” earlier in this section.	
CSR GUID	3B34004E - 1B84 - 11D8 - 83B3 - 00105A5BAE55	
Field	**Bit**	**Description**
Presence Inq (Read only)	[0]	Presence of the frame counter stamp feature on the camera: 0 = not present 1 = present
----	[1 ... 30]	Reserved
Enable (Read / write)	[31]	Enable / disable this feature: 0 = disable 1 = enable

CRC Checksum Chunk Layout

The CRC checksum is an exception to the normal chunk structure. The CRC chunk is always 32 bits wide and is always the last chunk appended to the image data. The lower 16 bits of the chunk are filled with the checksum and the upper 16 bits are filled with zeros.

Bit	Description
[0 ... 7]	CRC checksum low byte
[8 .... 15]	CRC checksum high byte
[16 ... 23]	0x00
[24 ... 31]	0x00

Using the Checksum to Check the Data Integrity

When the checksum smart feature is enabled, the following two C functions can be used to check if an acquired frame contains a valid CRC checksum. The user must pass the acquired image buffer and the buffer's length in bytes to the CheckBuffer() function. The CheckBuffer() function uses the CRC16() function to calculate the checksum.

These two code samples are intended to aid you in developing your application. They are provided solely as examples.

```
//brief Calculates a 16 bit CRC checksum
//param pData Pointer to the data buffer
//param nbyLength Size of the buffer in bytes
//return The CRC checksum

unsigned short CRC16(const unsigned char *pData, unsigned long nbyLength )
{
       unsigned long i, j, c, bit;
       unsigned long crc = 0;
       for (i=0; i<nbyLength; i++) {
             c = (unsigned long)*pData++;
             for (j=0x80; j; j>>=1) {
                   bit = crc & 0x8000;
                   crc <<= 1;
                   if (c & j) bit^= 0x8000;
                   if (bit) crc^= 0x1021;
             }
       }
       return (unsigned short) (crc & 0xffff);
```

```
}

//brief Verifies a frame buffer's CRC checksum
//param pData Pointer to the frame
//param nbyLength Size of frame in bytes
//return 1, if the check succeeds, 0 otherwise

int CheckBuffer(const unsigned char* pData, unsigned long nbyLength )
{
       unsigned long nCurrentCRC, nDesiredCRC;
       // Calculate the CRC checksum of the buffer. Don't take the last four bytes
       // containing the checksum into account
       nCurrentCRC = CRC16(pData, nbyLength - sizeof( unsigned long ) );
       // Retrieve the desired CRC value from the data buffer
     nDesiredCRC = ((unsigned long*) pData)[ nbyLength / sizeof ( unsigned long ) - 1];
       // Return TRUE if they are equal
       return nCurrentCRC == nDesiredCRC;
}
```

9.6 Non-reporting Smart Features

9.6.1 Green Level

According to the DCAM definition of white balance, only the intensities of red and blue are adjustable and green is not. The green level smart feature lets you adjust a correction factor for green.

To change the green correction factor, set the Green Level Value field of the Green Level CSR. The usable range of settings for this field is from 64 to 255. If the field is set to 64, green will have the a 1.0 correction factor and there will be no effect on your images. If the field is set to a higher value, green will have a higher correction factor and captured images will be more green.

To determine the correction factor for green, use this formula:

$$\text{Green Correction Factor} = \frac{\text{Green Value Setting}}{64}$$

Note

The green level smart feature does not add information to the image data stream and can be accessed even when the extended data stream feature is disabled.

The green level smart feature can be enabled regardless of the video format.

For more information about white balance, see Section 8.3 on page 157.

Control and Status Register for the Green Level Feature

Name	Green Level		
Address	See “Determining the Address of Smart Features CSRs” earlier in this section		
CSR GUID	3E6BEE2E - 0DBD - 11DB - 90E8 - 0030535BAE55		
Position	**Field**	**Bit**	**Description**
0	Presence Inq (Read only)	[0]	Presence of the green level feature on the camera: 0 = not present 1 = present
	Available Inq (Read only)	[1]	Current availability of the green level feature: 0 = not available for use 1 = available for use
	Error Inq (Read only)	[2]	Presence of an error condition for the green level feature: 0 = error not present 1 = error is present
	---	[3 ... 31]	Reserved
4	Min (Read only)	[0 ... 31]	Minimum value for the green level field. The value in the min field is an integer.
8	Max (Read only)	[0 ... 31]	Maximum value for the green level field. The value in the max field is an integer.
12	Increment (Read only)	[0 ... 31]	Increment by which the green level field can be adjusted. The value in the increment field is an integer.
16	Green Level (Read / write)	[0 ... 31]	Sets the green level. The value in this field is an integer.

9.6.2 Binning (All Models Except scA750-60)

Note

- The binning feature is only available on the monochrome cameras.
- The binning feature is not available on scA750-60 cameras.

Binning increases the camera's response to light by summing the charges from adjacent pixels into one pixel. Two types of binning are available: vertical binning and horizontal binning.

With vertical binning, adjacent pixels from 2 lines, 3 lines, or a maximum of 4 lines in the imaging sensor array are summed and are reported out of the camera as a single pixel. Figure 61 illustrates vertical binning.

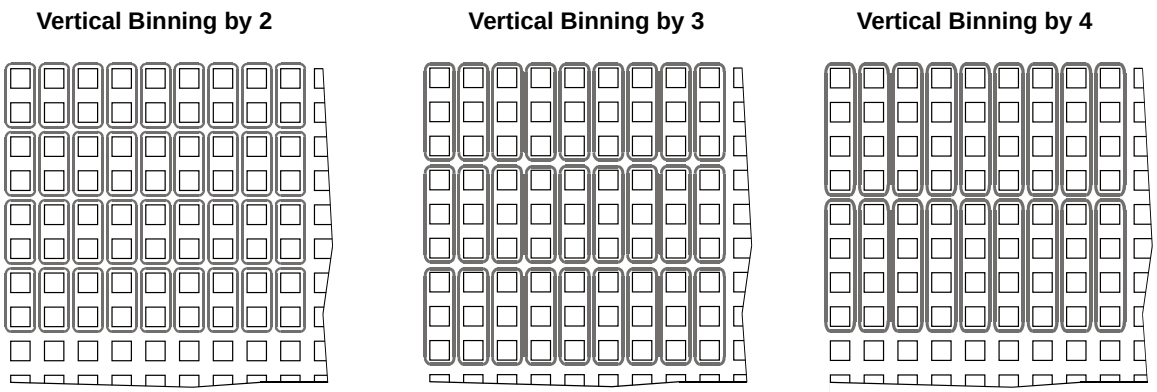


Fig. 61: Vertical Binning

With horizontal binning, adjacent pixels from 2 columns, 3 columns, or a maximum of 4 columns are summed and are reported out of the camera as a single pixel. Figure 62 illustrates horizontal binning.

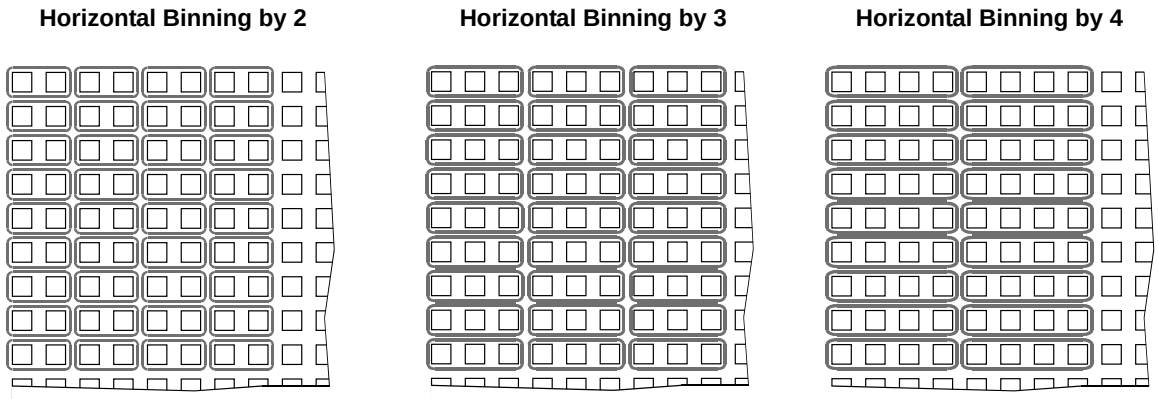


Fig. 62: Horizontal Binning

You can combine vertical and horizontal binning. This, however, may cause objects to appear distorted in the image. For more information on possible image distortion due to combined vertical and horizontal binning, see below.

Increased Response to Light

Using binning can greatly increase the camera's response to light. When binning is enabled, acquired images may look overexposed. If this is the case, you can reduce the lens aperture, reduce the intensity of your illumination, reduce the camera's exposure time setting, or reduce the camera's gain setting.

When using vertical binning, the limits for the minimum gain settings are automatically lowered. This allows you to use lower gain settings than would otherwise be available.

For the lowered limits on the minimum gain settings, see Section 8.1 on page 151.

Reduced Resolution

Using binning effectively reduces the resolution of the camera's imaging sensor. For example, the sensor in the scA780-54gm camera normally has a resolution of 782 (H) x 582 (V). If you set this camera to use horizontal binning by 3 and vertical binning by 3, the effective resolution of the sensor is reduced to 260 (H) by 194 (V). (Note that the 782 pixel horizontal dimension of the sensor was not evenly divisible by 3, so we rounded down to the nearest whole number.)

Possible Image Distortion

Objects will only appear undistorted in the image if the numers of binned lines and columns are equal. With all other combinations, the imaged objects will appear distorted. If, for example, vertical binning by 2 is combined with horizontal binning by 4 the widths of the imaged objects will appear shrunk by a factor of 2 compared to the heights.

If you want to preserve the aspect ratios of imaged objects when using binning you must use vertical and horizontal binning where equal numbers of lines and columns are binned, e.g. vertical binning by 3 combined with horizontal binning by 3.

Binning's Effect on AOI Settings

When you have the camera set to use binning, keep in mind that the settings for your area of interest (AOI) will refer to the binned lines and columns in the sensor and not to the physical lines in the sensor as they normally would. Another way to think of this is by using the concept of a "virtual sensor." For example, assume that you are using a scA780-54gm camera set for 3 by 3 binning as described above. In this case, you would act as if you were actually working with a 260 column by 194 line sensor when setting your AOI parameters. The maximum AOI width would be 260 and the maximum AOI height would be 194. When you set the X Offset and the Width for the AOI, you will be setting these values in terms of virtual sensor columns. And when you set the Y Offset and the Height for the AOI, you will be setting these values in terms of virtual sensor lines.

For more information about the area of interest (AOI) feature, see Section 7.2 on page 115.

Binning's Effect on the Sensor Readout and Frame Rate Formulas

In several areas of the manual, formulas appear for sensor readout time and for calculating the maximum frame rate. In several of these formulas, you must enter the current height of the area of interest (AOI). If you are not using binning, you would enter the height of the AOI in physical sensor lines. If binning is enabled, however, you must use the concept of a "virtual" sensor as described above and the height of the AOI that you use in the formulas would be in terms of virtual sensor lines.

The affected formulas appear on page 110 and page 119.

Control and Status Registers for the Binning Feature

Vertical Binning

Name	Vertical Binning		
Address	See “Determining the Address of Smart Features CSRs” earlier in this section		
CSR GUID	6CD17E4A - C718 - 11DB - 9430 - 0030535BAE55		
Position	**Field**	**Bit**	**Description**
0	Presence Inq (Read only)	[0]	Presence of the vertical binning feature on the camera: 0 = not present 1 = present
	Available Inq (Read only)	[1]	Current availability of the vertical binning feature: 0 = not available for use 1 = available for use
	Error Inq (Read only)	[2]	Presence of an error condition for the vertical binning feature: 0 = error not present 1 = error is present
	---	[3 ... 31]	Reserved
4	Min (Read only)	[0 ... 31]	Minimum value for the vertical binning field. The value in the min field is an integer.
8	Max (Read only)	[0 ... 31]	Maximum value for the vertical binning field. The value in the max field is an integer.
12	Increment (Read only)	[0 ... 31]	Increment by which the vertical binning field can be adjusted. The value in the increment field is an integer.
16	Vertical Binning (Read / write)	[0 ... 31]	Sets vertical binning. The value in this field is an integer.

Horizontal Binning

Name	Horizontal Binning		
Address	See “Determining the Address of Smart Features CSRs” earlier in this section		
CSR GUID	72DA87FA - C718 - 11DB - 96BA - 0030535BAE55		
Position	**Field**	**Bit**	**Description**
0	Presence Inq (Read only)	[0]	Presence of the horizontal binning feature on the camera: 0 = not present 1 = present
	Available Inq (Read only)	[1]	Current availability of the horizontal binning feature: 0 = not available for use 1 = available for use
	Error Inq (Read only)	[2]	Presence of an error condition for the horizontal binning feature: 0 = error not present 1 = error is present
	---	[3 ... 31]	Reserved
4	Min (Read only)	[0 ... 31]	Minimum value for the horizontal binning field. The value in the min field is an integer.
8	Max (Read only)	[0 ... 31]	Maximum value for the horizontal binning field. The value in the max field is an integer.
12	Increment (Read only)	[0 ... 31]	Increment by which the horizontal binning field can be adjusted. The value in the increment field is an integer.
16	Horizontal Binning (Read / write)	[0 ... 31]	Sets horizontal binning. The value in this field is an integer.

9.6.3 Lookup Table

9.6.3.1 Lookup Table Feature **(All Models Except scA750-60)**

Note

The information in this section applies to all camera models except the scA750-60 fm/fc. For information about scA750-60 cameras, see Section 9.6.3.2 on page 201.

On cameras equipped with a CCD sensor, pixel data is captured at 12 bit depth. When a monochrome camera is set for the Mono 16 color coding or a color camera is set for the Raw 16 color coding, the camera outputs 16 bits per pixel with 12 bits effective. Normally, the effective 12 bits transmitted out of the camera for each pixel directly represent the 12 bits reported by the camera's ADC. The lookup table smart feature lets you use a custom 12 bit to 12 bit lookup table to map the 12 bits reported out of the ADC to the effective 12 bits that will be transmitted by the camera.

The lookup table is essentially just a list of 4096 values, however, not every value in the table is actually used. If we number the values in the table from 0 through 4095, the table works like this:

- The number at location 0 in the table represents the effective 12 bits that will be transmitted out of the camera when the sensor reports that a pixel has a value of 0.
- The numbers at locations 1 through 7 are not used.
- The number at location 8 in the table represents the effective 12 bits that will be transmitted out of the camera when the sensor reports that a pixel has a value of 8.
- The numbers at locations 9 through 15 are not used.
- The number at location 16 in the table represents the effective 12 bits that will be transmitted out of the camera when the sensor reports that a pixel has a value of 16.
- The numbers at locations 17 through 23 are not used.
- The number at location 24 in the table represents the effective 12 bits that will be transmitted out of the camera when the sensor reports that a pixel has a value of 24.
- And so on.

As you can see, the table does not include a user defined 12 bit output value for every pixel value that the sensor can report. So what does the camera do when the sensor reports a pixel value that is between two values that have a defined 12 bit output? In this case, the camera performs a straight line interpolation to determine the value that it should transmit. For example, assume that the sensor reports a pixel value of 12. In this case, the camera would perform a straight line interpolation between the values at location 8 and location 16 in the table. The result of the interpolation would be reported out of the camera as the 12 bit output.

Another thing to keep in mind about the table is that location 4088 is the last location that will have a defined 12 bit value associated with it. (Locations 4089 through 4095 are not used.) If the sensor reports a value above 4088, the camera will not be able to perform an interpolation. In cases where the sensor reports a value above 4088, the camera simply transmits the 12 bit value from location 4088 in the table.

A table showing the layout of the control and status register for the lookup table smart feature on CCD cameras appears at the end of this section. If you examine the layout, you will notice that the first two quadlets of the register include bits that allow you to check for this feature's presence and to enable or disable the feature. These initial two quadlets are followed by 4096 quadlets. The 4096 quadlets contain the values that make up the customized lookup table.

The advantage of the lookup table feature is that it allows a user to customize the response curve of the camera. The graphs below show the effect of two typical lookup tables. The first graph is for a lookup table where the values are arranged so that the output of the camera increases linearly as the sensor output increases. The second graph is for a lookup table where the values are arranged so that the camera output increases quickly as the sensor output moves from 0 through 2048 and increases gradually as the sensor output moves from 2049 through 4096.

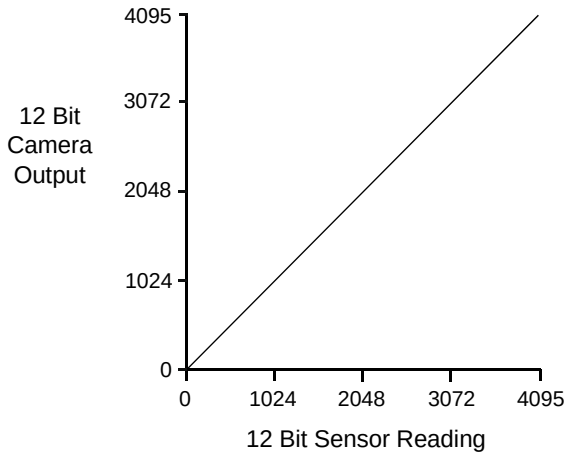


Fig. 63: Lookup Table with Values Mapped in a Linear Fashion

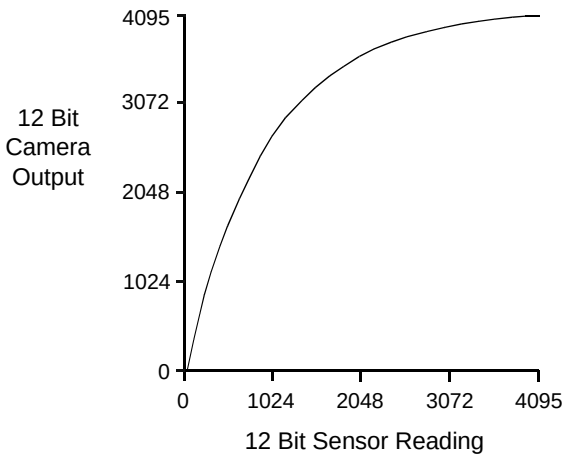


Fig. 64: Lookup Table with Values Mapped for Higher Camera Output at Low Sensor Readings

Using the Lookup Table to Get 8 Bit Output

As mentioned above, when the camera is set for the Mono 16 or the Raw 16 color codings, the lookup table is used to perform a 12 bit to 12 bit conversion. But the lookup table can also be used in 12 bit to 8 bit fashion. To use the table in 12 bit to 8 bit fashion, you enter 12 bit values into the table and enable the table as you normally would. But instead of setting the camera for a color coding that results in a camera output with 12 bits effective, you set the camera for a color coding that results in 8 bit output (such as Mono 8, Raw 8, YUV 4:2:2, or YUV 4:2:2 (YUYV)). In this situation, the camera will first use the values in the table to do a 12 bit to 12 bit conversion. It will then drop the least significant 4 bits of the converted value and will transmit the 8 most significant bits.

Note

The lookup table smart feature does not add information to the image data stream and can be accessed even when the extended data stream feature is disabled.

The gain and offset functions remain active when the lookup table is used. Gain and offset are applied to the pixel values reported from the sensor **before** the pixel values are processed with the lookup table.

The lookup table feature will work when the camera is set for any valid video format.

When you enable the lookup table feature, a default lookup table is automatically loaded into the camera. If you want use your own customized lookup table you must:

1. Use the look table feature Control and Status Register (CSR) to enable the lookup table feature.
2. Write the values for your customized lookup table to the CSR.

Control and Status Register for the Lookup Table Feature

Name	Lookup Table		
Address	See “Determining the Address of Smart Features CSRs” earlier in this section		
CSR GUID	B28C667C - DF9D - 11D7 - 8693 - 000C6E0BD1B0		
Position	Field	Bit	Description
0	Presence Inq (Read only)	[0]	Presence of the lookup table feature on the camera: 0 = not present 1 = present
	-----	[1 ... 30]	Reserved
	Enable (Read / write)	[31]	Enable / disable the lookup table feature: 0 = disable 1 = enable
4	In Depth Inq (Read only)	[0 ... 15]	Bit depth of the pixel data reported by the sensor
	Out Depth Inq (Read only)	[16 ... 31]	Bit depth of the pixel data transmitted from the camera
8	Quadlet 0 (Read / write)	[1 Quadlet]	Defines the effective 12 bits that will be transmitted from the camera when the 12 bit pixel value from the ADC is 0 (The 12 LSBs of the quadlet carry the data for the field. The 20 MSBs are all zeros.)
12 ... 36	Quadlet 1 ... 7 (Read / write)	[7 Quadlets]	Not used. The values written in these quadlets will be ignored.
40	Quadlet 8 (Read / write)	[1 Quadlet]	Defines the effective 12 bits that will be transmitted from the camera when the 12 bit pixel value from the ADC is 8
44 ... 68	Quadlet 9 ... 15 (Read / write)	[7 Quadlets]	Not used. The values written in these quadlets will be ignored.
72	Quadlet 16 (Read / write)	[1 Quadlet]	Defines the effective 12 bits that will be transmitted from the camera when the 12 bit pixel value from the ADC is 16
76 ... 100	Quadlet 17 ... 23 (Read / write)	[7 Quadlets]	Not used. The values written in these quadlets will be ignored.
104	Quadlet 24 (Read / write)	[1 Quadlet]	Defines the effective 12 bits that will be transmitted from the camera when the 12 bit pixel value from the ADC is 24
•	•	•	•
•	•	•	•
•	•	•	•
16296	Quadlet 4072 (Read / write)	[1 Quadlet]	Defines the effective 12 bits that will be transmitted from the camera when the 12 bit pixel value from the ADC is 4072

16300 ... 16324	Quadlet 4073 ... 4079 (Read / write)	[7 Quadlets]	Not used. The values written here will be ignored.
16328	Quadlet 4080 (Read / write)	[1 Quadlet]	Defines the effective 12 bits that will be transmitted from the camera when the 12 bit pixel value from the ADC is 4080
16332 ... 16356	Quadlet 4081 ... 4087 (Read / write)	[7 Quadlets	Not used. The values written here will be ignored.
16360	Quadlet 4088 (Read / write)	[1 Quadlet]	Defines the effective 12 bits that will be transmitted from the camera when the 12 bit pixel value from the ADC is 4088
16364 ... 16388	Quadlet 4089 ... 4095 (Read / write)	[7 Quadlets]	Not used. The values written here will be ignored.

Using the SFF Viewer to Upload Lookup Table Values

The Configurator window in the Basler SFF Viewer includes a drop down list that can be used to enable the lookup table feature. It also includes an *Upload* button that can be used to easily load a text file containing a customized lookup table into the camera. The file must be plain text and must be formatted correctly. Figure 65 shows part of a typical text file for a lookup table. The file must have 4096 lines with each line containing two comma separated values. The values in this table will be used to populate the 4096 quadlet fields in the control and status register for the lookup table feature.

For each pair of values in the text file, the value to the left of the comma represents a quadlet in the control register. The value to the right of the comma represents the setting for the quadlet. For example, the pair 24, 4 means that the value for quadlet 24 in the control register will be set to a value of 4.

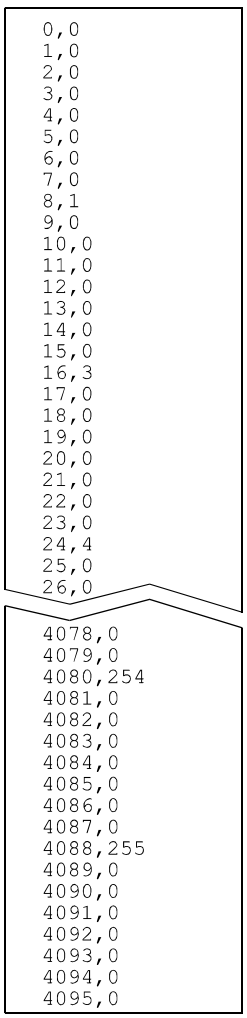


Fig. 65: Sample Text File for Use With **Upload** Button

9.6.3.2 Lookup Table Feature **(scA750-60 Only)**

Note

The information in this section only applies to scA750-60 fm/fc cameras. For information about the other camera models, see Section 9.6.3.1 on page 195.

On cameras equipped with a CMOS sensor, pixel data is captured at 10 bit depth. Before the pixel values are transmitted out of the camera, the two least significant bits are dropped and the pixel data is transmitted at 8 bit depth.

Normally, the 10 bit pixel data reported by the sensor's ADCs is directly used to generate the 8 bit output transmitted by the camera. The lookup table smart feature lets you use a custom 10 bit to 10 bit lookup table to map the 10 bits output reported by the ADCs to 10 bit values of your choice. The mapped 10 bit values will then be truncated and transmitted by the camera as 8 bit values.

The lookup table is essentially just a list of 1024 values, however, not every value in the table is actually used. If we number the values in the table from 0 through 1023, the table works like this:

- The number at location 0 in the table represents the mapped 10 bit value that will be used when the sensor reports that a pixel has a value of 0.
- The number at locations 1 is not used.
- The number at location 2 in the table represents the mapped 10 bit value that will be used when the sensor reports that a pixel has a value of 2.
- The number at location 3 is not used.
- The number at location 4 in the table represents the mapped 10 bit value that will be used when the sensor reports that a pixel has a value of 4.
- The number at location 5 is not used.
- The number at location 6 in the table represents the mapped 10 bit value that will be used when the sensor reports that a pixel has a value of 6.
- And so on.

As you can see, the table does not include a mapped 10 bit value for every pixel value that the sensor can report. So what does the camera do when the sensor reports a pixel value that is between two values that have a mapped 10 bit output? In this case, the camera performs a straight line interpolation between the two nearest neighbors to determine the value that it should use. For example, assume that the sensor reports a pixel value of 5. In this case, the camera would perform an interpolation between the values at location 4 and location 6 in the table. The result of the interpolation would be reported out of the camera as the mapped 10 bit value.

Another thing to keep in mind about the table is that location 1022 is the last location that will have a mapped 10 bit value associated with it. If the sensor reports a pixel value of 1023, the camera will not be able to perform an interpolation. In this case, the camera simply uses the mapped 10 bit value from location 1022 in the table.

A table showing the layout of the control and status register for the lookup table smart feature on CMOS cameras appears at the end of this section. If you examine the layout, you will notice that the first two quadlets of the register include bits that allow you to check for this feature's presence

and to enable or disable the feature. These initial two quadlets are followed by 1024 quadlets. The 1024 quadlets contain the values that make up the customized lookup table.

The advantage of the lookup table feature is that it allows a user to customize the response curve of the camera. The graphs below show the effect of two typical lookup tables. The first graph is for a lookup table where the values are arranged so that the output of the camera increases linearly as the sensor output increases. The second graph is for a lookup table where the values are arranged so that the camera output increases quickly as the sensor output moves from 0 through 512 and increases gradually as the sensor output moves from 513 through 1023.

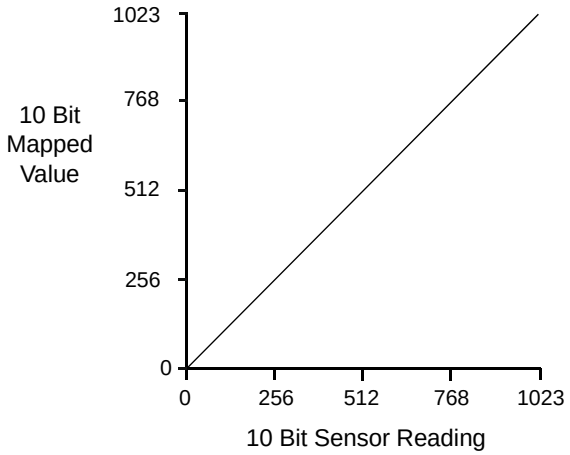


Fig. 66: Lookup Table with Values Mapped in a Linear Fashion

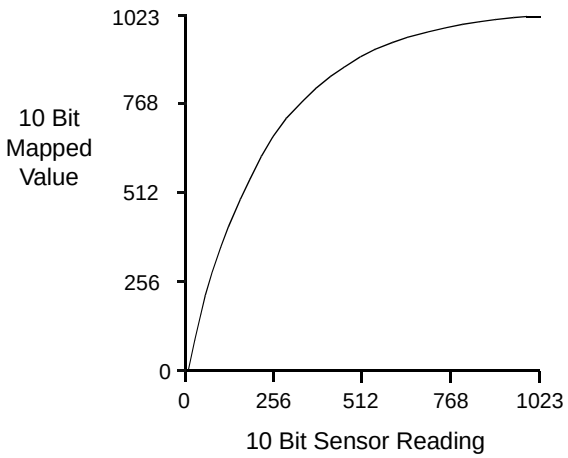


Fig. 67: Lookup Table with Values Mapped for Higher Camera Output at Low Sensor Readings

Note

The lookup table smart feature does not add information to the image data stream and can be accessed even when the extended data stream feature is disabled.

The gain and offset functions remain active when the lookup table is used. Gain and offset are applied to the pixel values reported from the sensor **before** the pixel values are processed with the lookup table.

The lookup table feature will work when the camera is set for any valid video format.

When you enable the lookup table feature, a default lookup table is automatically loaded into the camera. If you want use your own customized lookup table you must:

1. Use the look table feature Control and Status Register (CSR) to enable the lookup table feature.
2. Write the values for your customized lookup table to the CSR.

Control and Status Register for the Lookup Table Feature

Name	Lookup Table		
Address	See “Determining the Address of Smart Features CSRs” earlier in this section		
CSR GUID	B28C667C - DF9D - 11D7 - 8693 - 000C6E0BD1B0		
Position	Field	Bit	Description
0	Presence Inq (Read only)	[0]	Presence of the lookup table feature on the camera: 0 = not present 1 = present
	-----	[1 ... 30]	Reserved
	Enable (Read / write)	[31]	Enable / disable the lookup table feature: 0 = disable 1 = enable
4	In Depth Inq (Read only)	[0 ... 15]	Bit depth of the pixel data reported by the sensor
	Out Depth Inq (Read only)	[16 ... 31]	Bit depth of the pixel data transmitted from the camera
8	Quadlet 0 (Read / write)	[1 Quadlet]	Defines the 10 bit value that will be used when the 10 bit pixel value from the ADCs is 0 (The 10 LSBs of the quadlet carry the data for the field. The 22 MSBs are all zeros.)
12	Quadlet 1 (Read / write)	[1 Quadlets]	Not used. The value written to this quadlet will be ignored.

16	Quadlet 2 (Read / write)	[1 Quadlet]	Defines the 10 bit value that will be used when the 10 bit pixel value from the ADCs is 2
20	Quadlet 3 (Read / write)	[1 Quadlets]	Not used. The value written to this quadlet will be ignored.
24	Quadlet 4 (Read / write)	[1 Quadlet]	Defines the 10 bit value that will be used when the 10 bit pixel value from the ADCs is 4
28	Quadlet 5 (Read / write)	[1 Quadlets]	Not used. The value written to this quadlet will be ignored.
32	Quadlet 6 (Read / write)	[1 Quadlet]	Defines the 10 bit value that will be used when the 10 bit pixel value from the ADCs is 6
•	•	•	•
•	•	•	•
•	•	•	•
4080	Quadlet 1018 (Read / write)	[1 Quadlet]	Defines the 10 bit value that will be used when the 10 bit pixel value from the ADCs is 1018
4084	Quadlet 1019 (Read / write)	[1 Quadlets]	Not used. The value written to this quadlet will be ignored.
4088	Quadlet 1020 (Read / write)	[1 Quadlet]	Defines the 10 bit value that will be used when the 10 bit pixel value from the ADCs is 1020
4092	Quadlet 1021 (Read / write)	[1 Quadlets	Not used. The value written to this quadlet will be ignored.
4096	Quadlet 1022 (Read / write)	[1 Quadlet]	Defines the 10 bit value that will be used when the 10 bit pixel value from the ADCs is 1022
4100	Quadlet 1023 (Read / write)	[1 Quadlets]	Not used. The value written to this quadlet will be ignored.

Using the SFF Viewer to Upload Lookup Table Values

The Configurator window in the Basler SFF Viewer includes a drop down list that can be used to enable the lookup table feature. It also includes an *Upload* button that can be used to easily load a text file containing a customized lookup table into the camera. The file must be plain text and must be formatted correctly. Figure 65 shows part of a typical text file for a lookup table. The file must have 1024 lines with each line containing two comma separated values. The values in this table will be used to populate the 1024 quadlet fields in the control and status register for the lookup table feature.

For each pair of values in the text file, the value to the left of the comma represents a quadlet in the control register. The value to the right of the comma represents the setting for the quadlet. For example, the pair 24, 6 means that the value for quadlet 24 in the control register will be set to 6.

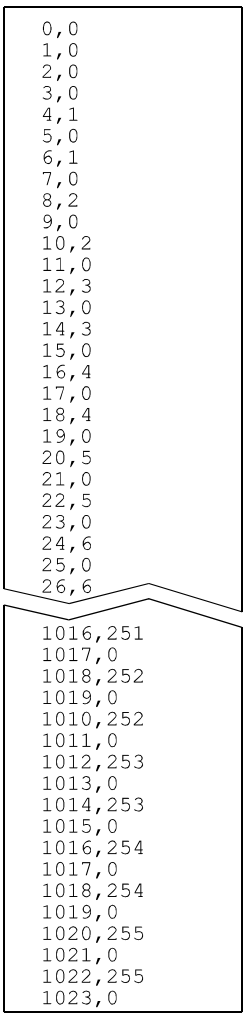


Fig. 68: Sample Text File for Use With **Upload** Button

9.6.4 Disable Parameter Limits

For each camera parameter, the allowed range of parameter values normally is limited. The factory limits are designed to ensure optimum camera operation and, in particular, good image quality. For special camera uses, however, it may be helpful to set parameter values outside of the factory limits.

The disable parameter limits feature lets you disable the factory parameter limits for certain parameters. When the factory parameter limits are disabled, the parameter values can be set within extended limits. Typically, the range of the extended limits is dictated by the physical restrictions of the camera's electronic devices, such as the absolute limits of the camera's variable gain control.

The values for the extended limits can be seen using the Basler BCAM Viewer or from within your application via the BCAM API.

Note

Currently, the parameter limits can only be disabled on the Gain feature.

Control and Status Register for the Disable Parameter Limits Feature

Name	Disable Parameter Limits		
Address	See "Determining the Address of Smart Features CSRs" earlier in this section		
CSR GUID	09A7203C - 5C63 - 11DC - 96E0 - 0030535BAE55		
Position	Field	Bit	Description
0	Presence Inq (Read only)	[0]	Presence of the disable parameter limits feature on the camera: 0 = not present 1 = present
	Enable (Read / write)	[1]	Enable / disable the disable parameter limits feature: 0 = disable 1 = enable
	------	[2 ... 31]	Reserved
4	Parameter Inq (Read only)	[0]	Defines gain as a parameter whose factory limits can be disabled.
		[1 ... 31]	Reserved
8	Limits Control (Read / write)	[0]	Enable / disable the parameter limits 0 = do not disable parameter limits 1 = disable parameter limits
		[1 ... 31]	Reserved

9.6.5 Debouncer

The debouncer feature aids in discriminating between valid and invalid input signals and only lets valid signals pass to the camera. The debouncer value specifies the minimum time that an input signal must remain high or remain low in order to be considered a valid input signal.

	We recommend setting the debouncer value so that it is slightly greater than the longest expected duration of an invalid signal. Setting the debouncer to a value that is too short will result in accepting invalid signals. Setting the debouncer to a value that is too long will result in rejecting valid signals.

Note that the debouncer delays a valid signal between its arrival at the camera and its transfer. The duration of the delay will be determined by the debouncer value.

The following diagram illustrates how the debouncer filters out invalid input signals, i.e. signals that are shorter than the debouncer value. The diagram also illustrates how the debouncer delays a valid signal.

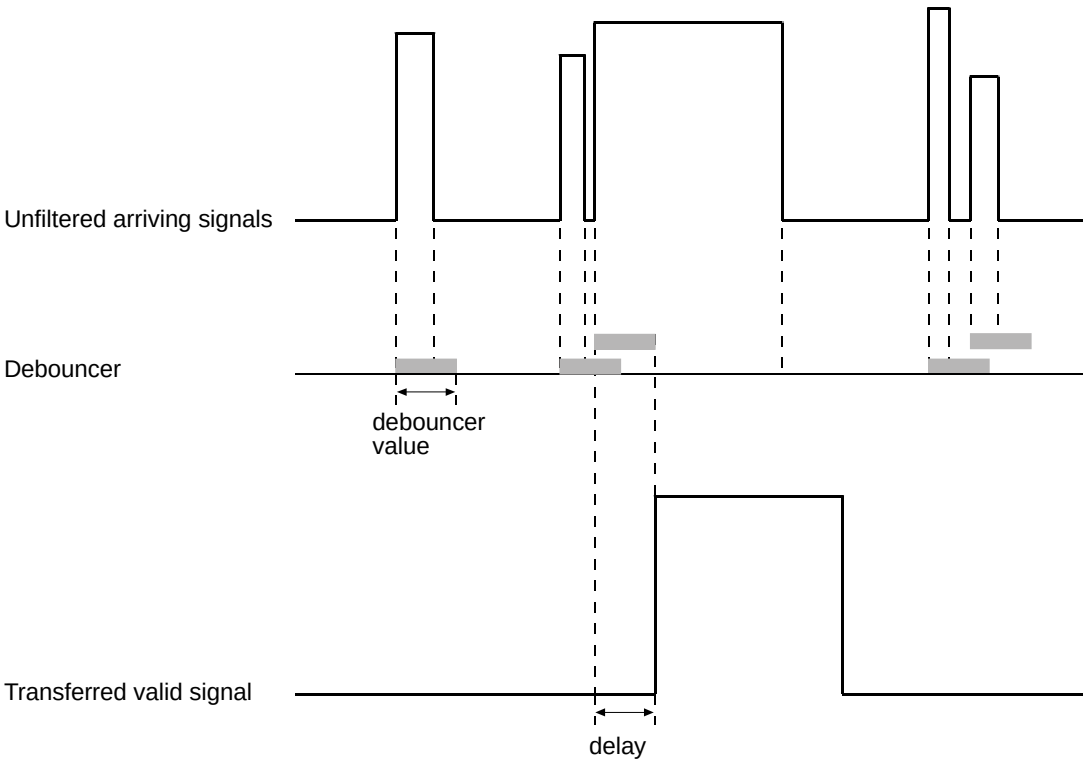


Fig. 69: Filtering of Input Signals by the Debouncer

Control and Status Registers for the Debouncer Feature

Debouncer for Input Port 0

Name	Debouncer Time Input 0		
Address	See “Determining the Address of Smart Features CSRs” earlier in this section		
CSR GUID	96CB33F8 - 91FC - 11DC - 8652 - 0030535BAE55		
Position	**Field**	**Bit**	**Description**
0	Presence Inq (Read only)	[0]	Presence of the debouncer time input 0 feature on the camera: 0 = not present 1 = present
	Available Inq (Read only)	[1]	Current availability of the debouncer time input 0 feature: 0 = not available for use 1 = available for use
	Error Inq (Read only)	[2]	Presence of an error condition for the debouncer time input 0 feature: 0 = error not present 1 = error is present
	---	[3 ... 31]	Reserved
4	Min (Read only)	[0 ... 31]	Minimum value for the debouncer time input 0 field. The value in the min field is an integer.
8	Max (Read only)	[0 ... 31]	Maximum value for the debouncer time input 0 field. The value in the max field is an integer.
12	Increment (Read only)	[0 ... 31]	Increment by which the debouncer time input 0 field can be adjusted. The value in the increment field is an integer.
16	Input Debouncer Time 0 (Read / write)	[0 ... 31]	Sets the debouncer time for input port 0. The value in this field is an integer.

Debouncer for Input Port 1

Name	Debouncer Time Input 1		
Address	See “Determining the Address of Smart Features CSRs” earlier in this section		
CSR GUID	0B46D0B2 - 9201 - 11DC - 8F30 - 0030535BAE55		
Position	**Field**	**Bit**	**Description**
0	Presence Inq (Read only)	[0]	Presence of the debouncer time input 1 feature on the camera: 0 = not present 1 = present
	Available Inq (Read only)	[1]	Current availability of the debouncer time input 1 feature: 0 = not available for use 1 = available for use
	Error Inq (Read only)	[2]	Presence of an error condition for the debouncer time input 1 feature: 0 = error not present 1 = error is present
	---	[3 ... 31]	Reserved
4	Min (Read only)	[0 ... 31]	Minimum value for the debouncer time input 1 field. The value in the min field is an integer.
8	Max (Read only)	[0 ... 31]	Maximum value for the debouncer time input 1 field. The value in the max field is an integer.
12	Increment (Read only)	[0 ... 31]	Increment by which the debouncer time input 1 field can be adjusted. The value in the increment field is an integer.
16	Input Debouncer Time 1 (Read / write)	[0 ... 31]	Sets the debouncer time for input port 1. The value in this field is an integer.

Test Images

All cameras include a test image mode as a smart feature. The test image mode is used to check the camera's basic functionality and its ability to transmit an image to the host PC. The test image mode can be used for service purposes and for failure diagnostics. In test mode, the image is generated internally by the camera's logic and does not use the optics, the imaging sensor, or the ADC. Six test images are available.

When a test image is active, the gain, brightness, and exposure time have no effect on the image.

The Effect of Camera Settings on Test Images

When any of the test image is active, the camera's analog features such as gain, brightness, and exposure time have no effect on the images transmitted by the camera. For test images 1, 2, 3 and 6, the cameras digital features, such as the lookup table, will also have no effect on the transmitted images. But for test images 4 and 5, the cameras digital features will affect the images transmitted by the camera. This makes test images 4 and 5 as good way to check the effect of using a digital feature such as the lookup table.

Note

The test image smart feature does not add information to the image data stream and can be enabled even when the extended data stream feature is disabled.

The test image feature will work when the camera is set for any valid video format.

Test Image 1 - Fixed Diagonal Gray Gradient (8 bit)

The 8 bit fixed diagonal gray gradient test image is best suited for use when the camera is set for monochrome 8 bit output. The test image consists of fixed diagonal gray gradients ranging from 0 to 255.

If the camera is set for 8 bit output and is operating at full resolution, test image one will look similar to Figure 70.

The mathematical expression for this test image:

Gray Value = [column number + row number] MOD 256

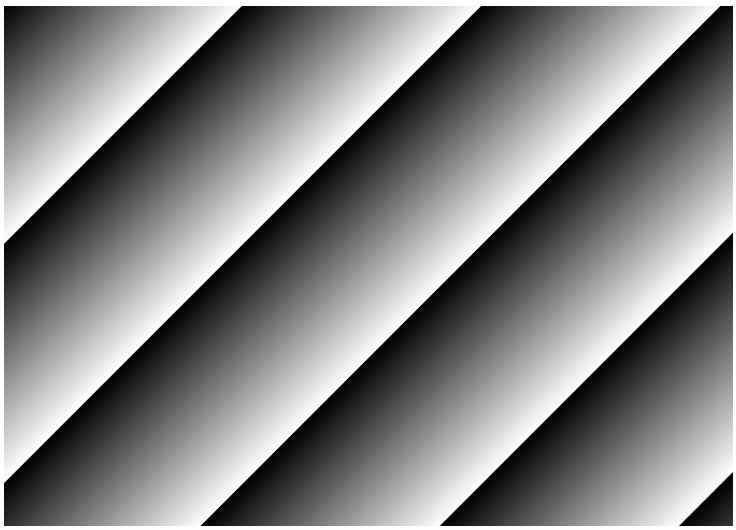


Fig. 70: Test Image One

Test Image 2 - Moving Diagonal Gray Gradient (8 bit)

The 8 bit moving diagonal gray gradient test image is similar to test image 1, but it is not stationary. The image moves by one pixel from right to left whenever a new image capture is initiated. The test pattern uses a counter that increments by one for each new image capture.

The mathematical expression for this test image is:

Gray Value = [column number + row number + counter] MOD 256

Test Image 3 - Moving Diagonal Gray Gradient (12 bit)

The 12 bit moving diagonal gray gradient test image is similar to test image 2, but it is a 12 bit pattern. The image moves by one pixel from right to left whenever a new image acquisition is initiated. The test pattern uses a counter that increments by one for each new image capture.

The mathematical expression for this test image is:

Gray Value = [column number + row number + counter] MOD 4096

Note

On scA750-60 cameras, test image 3 is a 10 bit pattern. Since these cameras do not have a 10 bit output mode available, use of test image 3 on scA750-60 cameras is not recommended.

Test Image 4 - Moving Diagonal Gray Gradient Feature Test (8 bit)

The basic appearance of test image 4 is similar to test image 2 (the 8 bit moving diagonal gray gradient image). The difference between test image 4 and test image 2 is this: if a camera feature that involves digital processing is enabled, test image 4 **will** show the effects of the feature while test image 2 **will not**. This makes test image 4 useful for checking the effects of digital features such as the luminance lookup table.

Test Image 5 - Moving Diagonal Gray Gradient Feature Test (12 bit)

The basic appearance of test image 5 is similar to test image 3 (the 12 bit moving diagonal gray gradient image). The difference between test image 5 and test image 3 is this: if a camera feature that involves digital processing is enabled, test image 5 **will** show the effects of the feature while test image 3 **will not**. This makes test image 5 useful for checking the effects of digital features such as the luminance lookup table.

Note

On scA750-60 cameras, test image 5 is a 10 bit pattern. Since these cameras do not have a 10 bit output mode available, use of test image 5 on scA750-60 cameras is not normally recommended. However, one situation where test image 5 is useful on scA750-60 cameras is to check the effect of the luminance lookup table.

Test Image 6 - Moving Diagonal Color Gradient

The moving diagonal color gradient test image is available on color cameras only and is designed for use when the camera is set for YUV output. As shown in Figure 71, test image six consists of diagonal color gradients. The image moves by one pixel from right to left whenever you signal the camera to capture a new image. To display this test pattern on a monitor, you must convert the YUV output from the camera to 8 bit RGB.

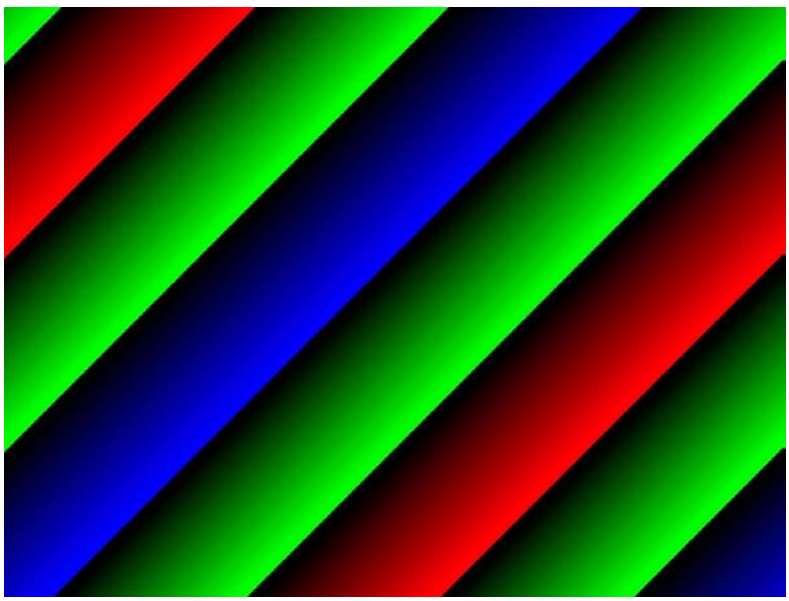


Fig. 71: Test Image Six

Control and Status Register for the Test Image Feature

Name	Test Images	
Address	See “Determining the Address of Smart Features CSRs” earlier in this section	
CSR GUID	2A411342 - C0CA - 4368 - B46E - EE5DEEBF0548	
Field	**Bit**	**Description**
Presence Inq (Read only)	[0]	Presence of the test image feature on the camera: 0 = not present 1 = present
-----	[1 ... 7]	Reserved
Image Inq 1 (Read only)	[8]	Presence of test image 1: 0 = not present 1 = present
Image Inq 2 (Read only)	[9]	Presence of test image 2: 0 = not present 1 = present
Image Inq 3 (Read only)	[10]	Presence of test image 3: 0 = not present 1 = present
Image Inq 4 (Read only)	[11]	Presence of test image 4: 0 = not present 1 = present
Image Inq 5 (Read only)	[12]	Presence of test image 5: 0 = not present 1 = present
Image Inq 6 (Read only)	[13]	Presence of test image 6: 0 = not present 1 = present
-----	[14 ... 15]	Reserved
Image On (Read / write)	[16 ... 18]	Enable / disable a test image: 0 = no test image active 1 = test image 1 active (fixed diagonal gray gradient - 8 bit) 2 = test image 2 active (moving diagonal gray gradient - 8 bit) 3 = test image 3 active (moving diagonal gray gradient - 12 bit) 4 = test image 4 active (moving diagonal gray gradient feature test - 8 bit) 5 = test image 5 active (moving diagonal gray gradient feature test - 12 bit) 6 = test image 6 active (moving diagonal color gradient)
-----	[19 ... 31]	Reserved

9.6.6 Trigger Flag and Trigger Counter

The cameras include a trigger flag and trigger counter feature. The trigger counter increments by one each time an image capture is triggered regardless of whether the trigger is internal (one shot or continuous shot commands) or is external (hardware or software trigger). Triggers that occur when the camera is not ready are discarded and not counted. The trigger counter wraps to zero after 65535 is reached.

If one or more triggers has been detected since the last time the Trigger Flag field was read, the trigger flag is set to one. The flag self clears with each read access.

Writes to the Trigger Count or Trigger Flag fields are ignored.

The counter field or the flag field can be polled by your camera control software to detect the receipt of a trigger signal by the camera. The camera control software can react synchronously to each trigger signal received. By using the results of the polling to know when a trigger signal is received by the camera, you can eliminate the need for a hard wired signal from the hardware device that is issuing the trigger. Keep in mind that your degree of precision depends on your polling frequency and the 1394 bus latency.

Note

The trigger flag and trigger counter smart feature does not add information to the image data stream and can be accessed even when the extended data stream feature is disabled.

The trigger flag and counter feature is always enabled regardless of the video format.

Control and Status Register for the Trigger Flag and Counter Feature

Name	Trigger Flag and Counter		
Address	See “Determining the Address of Smart Features CSRs” earlier in this section		
CSR GUID	16C31A78 - 3F75 - 11D8 - 94EC - 00105A5BAE55		
Position	**Field**	**Bit**	**Description**
0	Presence Inq (Read only)	[0]	Presence of the trigger flag and counter feature on the camera: 0 = not present 1 = present
	-----	[1 ... 15]	Reserved
	Trigger Count (Read only)	[16 ... 31]	The trigger counter increments by one each time an image capture is triggered. The counter is reset at power on or when an initialize command is issued.
4	-----	[0 ... 30]	Reserved
	Trigger Flag (Read only)	[31]	The flag is set to 1 by each trigger. It is cleared by a read access to this register.

9.6.7 Output Port Configuration

The cameras are equipped with four physical output ports designated as Output Port 0, Output Port 1, Output Port 2, and Output Port 3. The output port configuration feature can be used to change the assignment of camera output signals (such as integrate enabled, trigger ready, or strobe control) to the physical output ports.

As shown in the tables below, there is a control and status register (CSR) for each physical output port. The Source Select field in each register is used to assign a camera signal to the associated output port. For example, the Source Select field in the register for Output Port 0 is used to assign a camera output signal to physical output port 0.

Each physical output port can be unassigned or it can have one and only one camera output signal assigned to it.

You can assign a camera output signal to more than one physical output port. For example, the Trigger Ready signal could be assigned to both physical output port 0 and physical output port 1.

The Source Select field can also be used to designate an output port as “user set.” If an output port is designated as user set, its state can be set to high or low by using the User Setting field in the CSR for the port.

The Invert field can be used to invert the signal before it is applied to the output port and the Monitor field can be used to check the current state of the output port.

When using the output port configuration feature, you should follow this sequence:

1. Read the Presence Inq field and the Source Select Inq field for the physical port you want to work with. Determine whether the port configuration feature is available for the port and if the source for the port is selectable.
2. Use the Source Select field to select a source for the output port.
   (If you select “User set” as the source, the state of the physical output port may change when you set the bits in the Source Select field. This is an artifact of the camera design.)
3. Check the Monitor Inq, Invert Inq, and User Setting Inq fields. The state of these fields will tell you if the Monitor, Invert, and User Setting fields are available. (The availability of the Monitor, Invert, and User Setting fields will vary depending on the selected source.)
4. If the Invert field is available, set the field as desired.
5. If you selected “User set” as the source, use the User Setting field to set the state of the output as desired.
6. If the Monitor field is available, use the field as desired to check the current state of the output.

Note

The output port configuration smart feature does not add information to the image data stream and can be accessed even when the extended data stream feature is disabled.

The output port configuration feature is always enabled regardless of the video format.

By default, the Integrate Enabled signal is assigned to physical output port 0 and the Trigger Ready Signal is assigned to physical output port 1.

For more information about the integrate enabled signal, see Section 6.8 on page 108.

For more information about the trigger ready signal, see Section 6.7 on page 103.

For more information about the strobe control signals, see Section 8.5 on page 160.

Control and Status Registers for the Output Port Configuration Feature

Name	Output Port 0 Configuration		
Address	See “Determining the Address of Smart Features CSRs” earlier in this section		
CSR GUID	5A889D7E - 41E5 - 11D8 - 845B - 00105A5BAE55		
Position	**Field**	**Bit**	**Description**
0	Presence Inq (Read only)	[0]	Presence of the output port 0 configuration feature on the camera: 0 = not present 1 = present
	Monitor Inq (Read only)	[1]	Presence of the monitor field: 0 = not present 1 = present
	Invert Inq (Read only)	[2]	Presence of the invert field: 0 = not present 1 = present
	User Setting Inq (Read only)	[3]	Presence of the user setting field: 0 = not present 1 = present
	-----	[4 ... 26]	Reserved
	Source Select (Read / write)	[27 ... 31]	Write a value to select a source signal for output port 0: 0 = integrate enabled signal 1 = trigger ready signal 2 = reserved 3 = user set (state can be set with the User Setting field) 4 = strobe control signal
4	Source Select Inq (Read only)	[0 ... 31]	If bit *n* is set, then value *n* is valid for use in the Source Select field. For example, if bit 0 is set, then 0 is a valid value for use in the Source Select field. If bit 1 is set, then 1 is a valid value for use in the Source Select field. Etc.
8	-----	[0 ... 30]	Reserved
	Monitor (Read only)	[31]	Shows the current state of the output: 0 = low (non-conducting) 1 = high (conducting)
12	-----	[0 ... 30]	Reserved
	Invert (Read / write)	[31]	Enables signal inversion: 0 = do not invert 1 = invert
16	-----	[0 ... 30]	Reserved
	User Setting (Read / write)	[31]	If the Source Select field is set to “user set”, this field sets the state of the output: 0 = low (non-conducting) 1 = high (conducting) (Sets the state of the output **before** the inverter.)
20	-----	[0 ... 31]	Reserved

Name	Output Port 1 Configuration		
Address	See “Determining the Address of Smart Features CSRs” earlier in this section		
CSR GUID	949D820A - 4513 - 11D8 - 9EB1 - 00105A5BAE55		
Position	**Field**	**Bit**	**Description**
0	Same as port 0		
4	Same as port 0		
8	Same as port 0		
12	Same as port 0		
16	Same as port 0		
20	Same as port 0		

Name	Output Port 2 Configuration		
Address	See “Determining the Address of Smart Features CSRs” earlier in this section		
CSR GUID	C14E5072 - 4513 - 11D8 - 81F3 - 00105A5BAE55		
Position	**Field**	**Bit**	**Description**
0	Same as port 0		
4	Same as port 0		
8	Same as port 0		
12	Same as port 0		
16	Same as port 0		
20	Same as port 0		

Name	Output Port 3 Configuration		
Address	See “Determining the Address of Smart Features CSRs” earlier in this section		
CSR GUID	E79233CA - 4513 - 11D8 - 9B9A - 00105A5BAE55		
Position	**Field**	**Bit**	**Description**
0	Same as port 0		
4	Same as port 0		
8	Same as port 0		
12	Same as port 0		
16	Same as port 0		
20	Same as port 0		

9.6.8 Shutter Time Base

When the camera is set to use a software trigger or is set to use a hardware trigger and the programmable mode, exposure time is determined by the camera's shutter time setting. The shutter time setting is actually a combination of two values. The first is the value in the Value field of the Shutter control register. The second is the Shutter Time Base value. The shutter time setting is the product of these two values:

Shutter Time Setting = (Value Field of the Shutter Control Register) x (Shutter Time Base Value)

By default, the shutter time base value is fixed at 0.000020 s (20 µs) on all camera models except the scA750-60. On scA750-60 cameras, the default value for the shutter time base is 0.000031 s (31 µs).

The shutter time setting is normally adjusted by changing the value in the Value field of the Shutter control register. However, if you require a shutter time setting that is shorter or longer than what you can achieve by changing the value field alone, the Shutter Time Base CSR can be used to change the shutter time base.

On all camera models except the scA750-60, the shutter time base can be changed in increments of 0.000001 s (1 µs). On scA750-60 cameras, the shutter time base can be changed in increments of 0.000031 s (31 µs).

On all camera models except the scA750-60, you can obtain the maximum possible shutter time (10 s) by setting the value in the Value field of the Shutter control register to 1 and the Shutter Time Base value to 10 s.

On scA750-60 cameras, you can obtain the maximum possible shutter time (0.126976 s) by e.g. setting the value in the Value field of the Shutter control register to 2048 and the Shutter Time Base value to 0.000062 s.

To change the shutter time base:

- Make sure the Enable field in the Shutter Time Base CSR is set to 1
- Set the Time Base field to your desired time base value

Example

Assume that you are using an scA640-70 camera and you have set the Value field of the Shutter control register to 325. Also assume that you have enabled the time base smart feature and that you have set the Time Base field in the Shutter Time Base CSR to 0.000150 s. In this case:

Shutter Time Setting = (Value Field of the Shutter Control Register) x (Shutter Time Base Value)

Shutter Time Setting = (325) x (0.000150 s)

Shutter Time Setting = 0.048750 s

Note

The shutter time base smart feature does not add information to the image data stream and can be accessed even when the extended data stream feature is disabled.

The shutter time base smart feature can be enabled regardless of the video format.

For more information about triggering, exposure time, and the shutter setting, see Section 6 on page 85.

Control and Status Register for the Shutter Time Base Feature

Name	Shutter Time Base		
Address	See “Determining the Address of Smart Features CSRs” earlier in this section		
CSR GUID	648BE1DA - A416 - 11D8 - 9B47 - 00105A5BAE55		
Position	**Field**	**Bit**	**Description**
0	Presence Inq (Read only)	[0]	Presence of the shutter time base feature on the camera: 0 = not present 1 = present
	-----	[1 ... 30]	Reserved
	Enable (Read only)	[31]	Enable / disable this feature: 0 = disable 1 = enable This feature is always enabled
4	Increment (Read only)	[0 ... 31]	Increment (in seconds) by which the shutter time base field can be adjusted. The value in the increment field is a standard IEEE-754 single precision (32 bit) floating point number.
8	Min (Read only)	[0 ... 31]	Minimum value (in seconds) for the shutter time base field. The value in the min field is a standard IEEE-754 single precision (32 bit) floating point number.
12	Max (Read only)	[0 ... 31]	Maximum value (in seconds) for the shutter time base field. The value in the max field is a standard IEEE-754 single precision (32 bit) floating point number.
16	Shutter Time Base (Read / write)	[0 ... 31]	Sets the shutter time base in seconds. The value in the time base field is a standard IEEE-754 single precision (32 bit) floating point number.

9.6.9 Strobe Delay Time Base

The strobe delay time base smart feature can be used to change the delay time base for the strobe control feature.

Changing the Strobe Delay Time Base

The delay for any one of the strobe signals is determined by a combination of two values. The first is the setting in the Delay Value field of the corresponding Strobe Control register and the second is the Strobe Delay Time Base. For example, the Strobe 0 delay will be determined by the product of the following two values:

Strobe 0 Delay = (Strobe 0 Delay Value Setting) x (Strobe Delay Time Base)

The strobe delay time base is fixed at 0.000001 s (1 µs) by default and the delay time for one of the four available strobe control signals is normally adjusted by changing the setting in the Delay Value field of the corresponding Strobe Control register. However, if you require a delay that is longer than what you can achieve by changing the strobe delay value alone, the Strobe Delay Time Base CSR can be used to change the strobe delay time base.

To change the strobe delay time base:

- Set the Time Base field in the Strobe Delay Time Base CSR to your desired time base value

Example

Assume that you have set the Delay Value field of the Strobe 0 control register to 186. Also assume that you have set the Strobe Delay Time Base field in the Strobe Delay Time Base CSR to 0.000014 s. In this case:

Strobe 0 Delay = (Strobe 0 Delay Value Setting) x (Strobe Delay Time Base)

Strobe 0 Delay = (186) x (0.000014 s)

Strobe 0 Delay = 0.002604 s

Note

There is only one setting for the strobe delay time base and this single setting is used by all of the available strobe outputs.

The strobe delay time base smart feature does not add information to the image data stream and can be accessed even when the extended data stream feature is disabled.

The strobe delay time base smart feature can be enabled regardless of the video format.

For more information about strobe control signals, see Section 8.5 on page 160.

Control and Status Register for the Strobe Delay Time Base Feature

Name	Strobe Delay Time Base		
Address	See “Determining the Address of Smart Features CSRs” earlier in this section.		
CSR GUID	BB04737C - 0DC0 - 11DB - 97DF - 0030535BAE55		
Position	**Field**	**Bit**	**Description**
0	Presence Inq (Read only)	[0]	Presence of the strobe delay time base feature on the camera: 0 = not Present 1 = present
	Available Inq (Read only)	[1]	Current availability of the strobe delay time base feature: 0 = not available for use 1 = available for use
	Error Inq (Read only)	[2]	Presence of an error condition for the strobe delay time base feature: 0 = error not present 1 = error is present
	---	[3 ... 31]	Reserved
4	Increment (Read only)	[0 ... 31]	Increment (in seconds) by which the strobe delay time base field can be adjusted. The value in the increment field is a standard IEEE-754 single precision (32 bit) floating point number.
8	Min (Read only)	[0 ... 31]	Minimum value (in seconds) for the strobe delay time base field. The value in the min field is a standard IEEE-754 single precision (32 bit) floating point number.
12	Max (Read only)	[0 ... 31]	Maximum value (in seconds) for the strobe delay time base field. The value in the max field is a standard IEEE-754 single precision (32 bit) floating point number.
16	Strobe Delay Time Base (Read / write)	[0 ... 31]	Sets the strobe delay time base in seconds. The value in the strobe delay time base field is a standard IEEE-754 single precision (32 bit) floating point number. Default = 0.000001 second

9.6.10 Strobe Duration Time Base

The strobe duration time base smart feature can be used to change the duration time base for the strobe control feature.

Changing the Strobe Duration Time Base

The duration of any one of the strobe signals is determined by a combination of two values. The first is the setting in the Duration Value field of the corresponding Strobe Control register and the second is the Strobe Duration Time Base. For example, the Strobe 0 duration will be determined by the product of the following two values:

Strobe 0 Duration = (Strobe 0 Duration Value Setting) x (Strobe Duration Time Base)

The strobe duration time base is fixed at 0.000001 s (1 µs) by default and the duration time for one of the four available strobe control signals is normally adjusted by changing the setting in the Duration Value field of the corresponding Strobe Control register. However, if you require a duration that is longer than what you can achieve by changing the strobe duration value alone, the Strobe Duration Time Base CSR can be used to change the strobe duration time base.

To change the strobe duration time base:

- Set the Time Base field in the Strobe Duration Time Base CSR to your desired time base value

Example

Assume that you have set the Duration Value field of the Strobe 0 control register to 200. Also assume that you have set the Strobe Duration Time Base field in the Strobe Duration Time Base CSR to 0.000015 s. In this case:

Strobe 0 Duration = (Strobe 0 Duration Value Setting) x (Strobe Duration Time Base)

Strobe 0 Duration = (200) x (0.000015 s)

Strobe 0 Duration = 0.0030 s

Note

There is only one setting for the strobe duration time base and this single setting is used by all of the available strobe outputs.

The strobe duration time base smart feature does not add information to the image data stream and can be accessed even when the extended data stream feature is disabled.

The strobe duration time base smart feature can be enabled regardless of the video format.

For more information about strobe control signals, see Section 8.5 on page 160.

Control and Status Register for the Strobe Duration Time Base Feature

Name	Strobe Duration Time Base		
Address	See “Determining the Address of Smart Features CSRs” earlier in this section		
CSR GUID	C345C72A - 0DC0 - 11DB - 893C - 0030535BAE55		
Position	**Field**	**Bit**	**Description**
0	Presence Inq (Read only)	[0]	Presence of the strobe duration time base feature on the camera: 0 = not present 1 = present
	Available Inq (Read only)	[1]	Current availability of the strobe duration time base feature: 0 = not available for use 1 = available for use
	Error Inq (Read only)	[2]	Presence of an error condition for the strobe duration time base feature: 0 = error not present 1 = error is present
	---	[3 ... 31]	Reserved
4	Increment (Read only)	[0 ... 31]	Increment (in seconds) by which the strobe duration time base field can be adjusted. The value in the increment field is a standard IEEE-754 single precision (32 bit) floating point number.
8	Min (Read only)	[0 ... 31]	Minimum value (in seconds) for the strobe duration time base field. The value in the min field is a standard IEEE-754 single precision (32 bit) floating point number.
12	Max (Read only)	[0 ... 31]	Maximum value (in seconds) for the strobe duration time base field. The value in the max field is a standard IEEE-754 single precision (32 bit) floating point number.
16	Strobe Duration Time Base (Read / write)	[0 ... 31]	Sets the strobe duration time base in seconds. The value in the duration time base field is a standard IEEE-754 single precision (32 bit) floating point number. Default = 0.000001 second

9.6.11 Extended Version Information

The cameras include a register that contains version numbers for the camera's internal software. For troubleshooting purposes, Basler technical support may ask you to read this register and to supply the results.

Note

The extended version information smart feature does not add information to the image data stream and can be accessed even when the extended data stream feature is disabled.

The extended version feature will work when the camera is set for any valid video format.

The Basler BCAM 1394 Driver includes a program called the BCAM viewer. You can also access the extended version information by using the properties function in the BCAM viewer.

Control and Status Register for the Extended Version Information Feature

Name	Extended Version Information	
Address	See "Determining the Address of Smart Features CSRs" earlier in this section	
CSR GUID	2B2D8714 - C15E - 4176 - A235 - 6EF843D747B4	
Field	**Bit**	**Description**
Presence Inq (Read only)	[0]	Presence of the extended version information feature on the camera: 0 = not present 1 = present
-----	[1 ... 7]	Reserved
Length	[8 ... 15]	Specifies the length in quadlets of the string in the Version Info field
-----	[16 ... 31]	Reserved
Version Info	[n Bytes]	An ASCII character string that includes the version numbers for the camera's internal software including the camera's "firmware ID" number. The length of this string field is equal to the number of quadlets given in the "length" field above.

9.6.12 Startup Memory Channel

The cameras include four memory channels that can be used to store camera configuration sets. Memory channel 0 contains a default configuration set with factory settings. Channels 1, 2, and 3 can be used to store user created configuration sets. The startup memory channel smart feature lets you designate a memory channel and when the camera is powered on or reset, the contents of the designated channel will be loaded into the active set in the camera's volatile memory.

To designate a startup memory channel, write a value to the Channel field of the Startup Memory Channel CSR.

Note

The startup memory channel smart feature does not add information to the image data stream and can be accessed even when the extended data stream feature is disabled.

The startup memory channel smart feature is only available when the camera is set for video format 7.

You can only designate memory channel 1, 2, or 3 as the startup channel if you have previously saved a configuration set into the designated memory channel. You can't use an empty memory channel as the startup channel.

For more information about memory channels and configuration sets, Section 8.8 on page 165

Control and Status Register for the Startup Memory Channel Feature

Name	Startup Memory Channel		
Address	See "Determining the Address of Smart Features CSRs" earlier in this section		
CSR GUID	93A06C5C - 87BF - 11D8 - 86DD - 00105A5BAE55		
Position	**Field**	**Bit**	**Description**
0	Presence Inq (Read only)	[0]	Presence of the trigger flag and counter feature on the camera: 0 = not present 1 = present
	-----	[1 ... 27]	Reserved
	Channel (Read / write)	[28 ... 31]	Selects a memory channel. At camera power on or reset, the configuration set in the selected channel will be loaded into the camera's active configuration set. 0 = channel 0 (default configuration set) 1 = channel 1 2 = channel 2 3 = channel 3 Default = 0

10 Using Multiple Cameras on a Single Bus

This section includes information about using multiple cameras on a single IEEE 1394 bus.

10.1 Using Multiple Cameras Where All Devices are 1394b

Most of the information included in this manual assumes that you have a single camera attached to your IEEE 1394b bus. But is it also quite common to attach more than one camera to a single bus. One of the main advantages of the IEEE 1394 bus architecture is that it is designed to handle multiple devices (such as cameras) connected to a single bus. And the connected devices can share the available bandwidth on the bus.

One way you can manage two cameras on a single bus is to operate the cameras so that only on camera is transmitting an image at any given time. In this situation, the camera transmitting images can use 100% of the bus bandwidth. In many situations, however, you would like to have two (or more) cameras transmitting images at the same time. In this case, the cameras that are transmitting images simultaneously must share the available bus bandwidth.

To understand how bandwidth is shared on an IEEE 1394 bus, we need to look at a few bus architecture basics. The IEEE 1394b bus operates on a 125 microsecond cycle. During each cycle, the bus can carry a single packet from one device with a packet size up to 8192 bytes. As an alternative, the bus can carry several packets from different devices where the sum of the packet sizes is 8192 bytes or less. These two situations are illustrated in Figure 72.

In situation 1 shown in the figure, a single camera (camera A) is attached to the bus and we want that camera to use 100% of the bandwidth available during each bus cycle. In this case, we would set the camera so that it would put 8192 bytes into the packet that it sends on each cycle of the bus.

In situation 2, we have three cameras (cameras A, B, and C) attached to the bus and all three cameras will transmit image data simultaneously. We want camera A to use 25%, of the available bus bandwidth, camera B to use 25%, and camera 3 to use 50%. In this case, we would set camera A so that it would put 2048 bytes, i.e., 25% of the 8192 byte maximum, into each packet it sends. We would set camera B so that it would put 2048 bytes (25% of 8192) into each packet it sends. And we would set camera C so that it would put 4096 bytes (50% of the 8192) into each packet it sends. As shown in the figure, the bus carries the packets sequentially on each cycle. The total byte load in all of the packets combined is 8192 and is equal to the maximum allowed per cycle. Note that we could have made the packet sizes smaller and thus the total byte load per cycle would be less than the maximum allowed. It is OK to make the total byte load smaller than the maximum, but not larger.

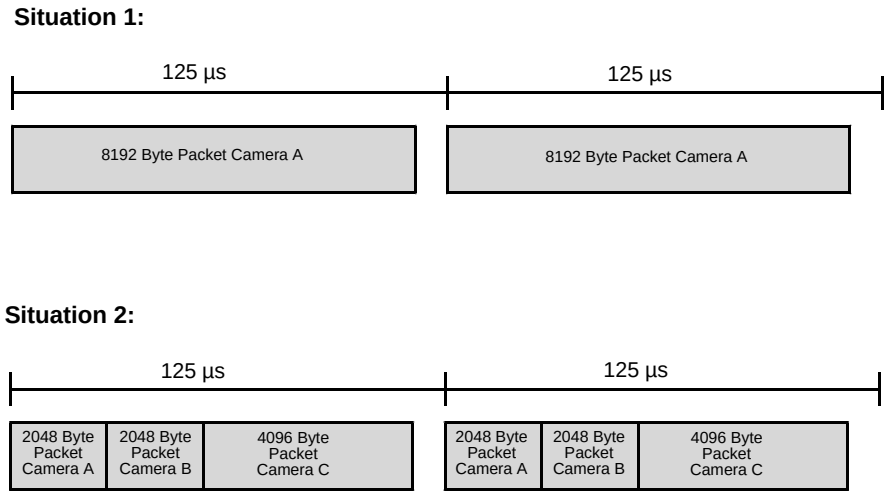


Fig. 72: Packet Transmission During Bus Cycles

When you are operating a camera in video format 7, a setting called the Bytes per Packet is used to set the size of the packet that the camera will transmit on each cycle of the bus. For an IEEE 1394b camera attached to an IEEE 1394b bus, the minimum value for this setting is 1 byte and the maximum is 8192 bytes. If you set the bytes per packet to 8192, the camera will use 100% of the available bus bandwidth when it is transmitting images. If you set the bytes per packet to a lower value, the camera will use less of the bandwidth. For example, if you set the value to 5120 (62.5% of 8192), then the camera will send 5120 byte packets when it is transmitting image data and will use 62.5% of the available bus bandwidth.

The bytes per packet is set by changing the value in the Bytes Per Packet field of the Bytes Per Packet register in the Format 7 control register group. For more information about the Format 7 control registers and the Bytes per Packet field, see page 278.

The Basler BCAM 1394 Driver includes a method call for setting the bytes per packet. For more information, see the online documentation delivered with the BCAM Driver.

10.2 Using Multiple Cameras Where 1394a and 1394b Devices are Mixed

The descriptions in the previous section assume that all of the devices on the bus are IEEE 1394b devices. If the bus has mixed IEEE 1394a devices and IEEE 1394b devices, determining how to share bandwidth between devices is a bit more difficult. As a first step toward understanding the situation, consider the difference between 1394a devices and 1394b devices:

- A 1394a device can transmit at what is known as S400 speed (400 Mbit/s).
- During a single bus cycle, a device operating at S400 speed can transmit a single packet of up to 4096 bytes. Alternatively, several devices operating at S400 speed can transmit packets during a single bus cycle as long as the sum of the bytes in the packets is 4096 bytes or less.
- A 1394b device can transmit at what is known as S800 speed (800 Mbit/s).
- During a single bus cycle, a device operating at S800 speed can transmit a single packet of up to 8192 bytes. Alternatively, several devices operating at S800 speed can transmit packets during a single bus cycle as long as the sum of the bytes in the packets is 8192 bytes or less.

The next thing that we must consider in a bus that has mixed 1394a and 1394b devices is the speed at which each device will transmit:

- A 1394a device will always be capable of transmitting at S400 speed on a mixed 1394a / 1394b bus. (The 1394a device can transmit at slower speeds, but we are assuming that you always want to transmit at the fastest speed.)
- A 1394b device will transmit at S800 speed if all of the devices in its path to the host PC, including the adapter card in the PC, are 1394b devices. If the path to the PC passes through any 1394a device, then the 1394b device will transmit at S400 speed.

Figure 73 illustrates some situations where 1394a devices and 1394b devices are mixed on a single bus. If you look at the figure, you will notice:

- Camera 1 will transmit image data at S400 speed. This is simply because the camera itself is a 1394a device and S400 is the maximum speed for 1394a devices.
- Camera 2 will transmit image data at S400 speed. The camera is a 1394b device, which means that it is capable of S800 speed. But the camera's path to the host PC passes through a 1394a adapter, so this limits the camera's actual maximum speed to S400.
- Camera 3 will transmit image data at S800 speed. This is because the camera is a 1394b device and its path to the host PC passes through only 1394b devices.
- Camera 4 will transmit image data at S400 speed. This is simply because the camera itself is a 1394a device.
- Camera 5 will transmit image data at S400 speed. The camera is a 1394b device, but its path to the host PC passes through a 1394a hub, so this limits the camera's maximum speed to S400.
- Camera 6 will transmit image data at S400 speed. This is simply because the camera itself is a 1394a device.
- Camera 7 will transmit image data at S800 speed. This is because the camera is a 1394b device and its path to the host PC passes through only 1394b devices.

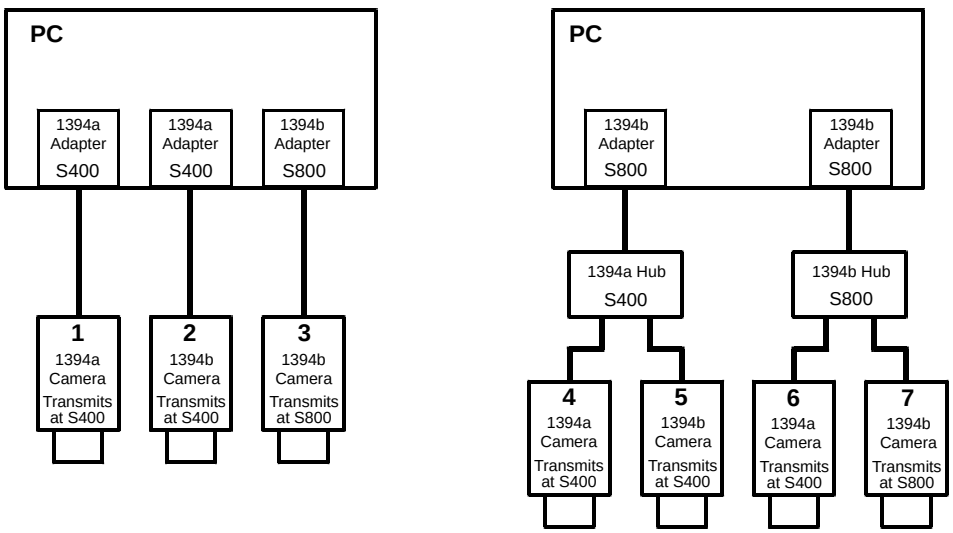

PC
1394a Adapter S400
1394a Adapter S400
1394b Adapter S800
1 1394a Camera Transmits at S400
2 1394b Camera Transmits at S400
3 1394b Camera Transmits at S800
PC
1394b Adapter S800
1394b Adapter S800
1394a Hub S400
1394b Hub S800
4 1394a Camera Transmits at S400
5 1394b Camera Transmits at S400
6 1394a Camera Transmits at S400
7 1394b Camera Transmits at S800

Fig. 73: Examples of Mixed Device Types

Note

The BCAM driver will always set each device to operate at the fastest possible speed for the current network configuration. This behavior of the driver can't be changed by the user.

So what does all of this mean when we are trying to share bandwidth between devices operating at different speeds on the same bus? Some examples will provide the best explanation.

Example 1: Assume that you have two cameras on the bus and that you want them to capture and transmit images simultaneously. Camera 1 is operating at S400 speed and the camera 2 is operating at S800 speed. Also assume that you want camera one to use 40% of the available bandwidth and camera 2 to use 60%. How would you set the bytes per packet on the cameras so that each one would use the desired portion of the bandwidth available in each bus cycle?

For camera 1, the calculation would be:

0.40 x 4096 = 1638.4 bytes per packet

(the bytes per packet must be set to a multiple of 4, so we would round the setting down to 1636)

For camera 2, the calculation would be:

0.60 x 8192 = 4915.2 bytes per packet

(the bytes per packet must be set to a multiple of 4, so we would round the setting down to 4912)

So in this case, you would set camera 1 for 1636 bytes per packet and camera 2 for 4912 bytes per packet.

You may be asking why we multiply the percentage for camera 1 by 4096 and the percentage for camera 2 by 8192. The reason is:

During the part of the bus cycle when the packet for camera 1 is transmitted, the bus will operate at S400 speed. At S400, the maximum number of bytes that can be transmitted in a bus cycle is 4096.

During the part of the bus cycle when the packet for camera 2 is transmitted, the bus will operate at S800 speed. At S800, the maximum number of bytes that can be transmitted in a bus cycle is 8192.

Example 2: Assume that you have three cameras on the bus and that you want these camera to capture and transmit images simultaneously. Camera one is operating at S800 speed and is set for 4200 bytes per packet. Camera two is operating at S800 speed and is set for 1800 bytes per packet. Camera 3 is operating at S400 speed and is set for 1000 bytes per packet. How much of the available bandwidth would each camera use?

For camera 1, the calculation would be:

4200 / 8192 = 51.3%

For camera 2, the calculation would be:

1800 / 8192 = 22.0%

For camera 3, the calculation would be:

1000 / 4096 = 24.4%

If you add these three results together, you find that 97.7% of the available bandwidth is being used. Keep in mind that if the sum was greater than 100%, you would need to lower the bytes per packet setting for one or more of the cameras.

10.2.1 Recommended Bytes Per Packet

When you change the value of the bytes per packet setting on a camera, there is something that you must keep in mind. When you lower the bytes per packet setting, the camera takes longer to transmit each acquired image. If you lower the bytes per packet enough, it will begin to restrict the maximum frame rate that the camera can achieve. A read only value called the Recommended Bytes per Packet can help you avoid this problem.

The recommended bytes per packet value indicates the lowest value you can use for the bytes per packet setting without restricting the camera's maximum allowed frame rate. Assume, for example, that you checked the recommend bytes per packet value and you found it to be 2400. This would mean that if you set the camera's bytes per packet at 2400 or more, the camera's maximum allowed frame rate would not be affected by the bytes per packet setting. And if you set the bytes per packet lower than 2400, the camera's maximum allowed frame rate would be affected. The farther below 2400 you set the bytes per packet, the more restricted the maximum frame rate would be.

For more information about the camera's maximum allowed frame rate and how it can be restricted by the bytes per packet setting, see Section 7.2.2 on page 118.

The recommended bytes per packet can be determined by reading the value in the Rec Bytes Per Packet field of the Bytes Per Packet register in the Format 7 control register group. For more information about the Format 7 control registers and the Rec Bytes per Packet field, see page 278.

The Basler BCAM 1394 Driver includes a method call for reading the recommended bytes per packet. For more information, see the online documentation delivered with the BCAM Driver.

11 Implemented Standard Registers

This section describes the standard registers implemented in the camera.

The structure of the status and control registers conforms to the “1394-Based Digital Camera Specification” issued by the 1394 Trade Association. The specification is commonly referred to as the “DCAM" standard or the “IIDC standard.” It is available at the 1394 Trade Association’s web site: www.1394ta.org. Except where noted, all registers conform to version 1.31 of the DCAM standard.

11.1 Inquiry Registers

The base address for all inquiry registers is:

Bus ID, Node ID, FFFF F0F0 0000

In each inquiry register description, an “Offset from Base Address” is provided. This a byte offset from the above base address. The address of an inquiry register equals the above base address plus the indicated offset.

Values are stated in decimal format except when marked 0x. Values marked as 0x (e.g., 0x123) are in hexadecimal format. **Bit 0 in each register is the most significant bit.**

11.1.1 Initialize Inquiry Register

Register Name:		Camera Initialize
Offset from Base Address:		0x000
Field	**Bit**	**Description**
Initialize	0	If you set this bit to 1, the camera will reset itself, break any state lock, and re-initialize itself to the settings in the currently assigned startup memory channel (or to the default settings if memory channels are not available). The bit is self cleared.
---	1 ... 31	Reserved

11.1.2 Inquiry Register for Video Formats

Each bit in the video format inquiry register indicates the availability of a specific format.

0 = format not available 1 = format available

Register Name:		Video Format Inquiry
Offset from Base Address:		0x100
Field Name	**Bit**	**Description**
Format 0	0	VGA non-compressed format
Format 1	1	Super VGA non-compressed format (1)
Format 2	2	Super VGA non-compressed format (2)
Format x	3 ... 5	Reserved
Format 6	6	Still image format
Format 7	7	Partial image size format
---	8 ... 31	Reserved

11.1.3 Inquiry Registers for Video Modes

Each bit in the video mode inquiry register indicates the availability of a specific video format and mode combination (e.g., Format 0, Mode 0).

0 = not available 1 = available

Register Name:		Video Mode Inquiry for Format 0
Offset from Base Address:		0x180
Field	**Bit**	**Description**
Mode 0	0	160 x 120, YUV 4:4:4, 24 bits/pixel
Mode 1	1	320 x 240, YUV 4:2:2, 16 bits/pixel
Mode 2	2	640 x 480, YUV 4:1:1, 12 bits/pixel
Mode 3	3	640 x 480, YUV 4:2:2, 16 bits/pixel
Mode 4	4	640 x 480, RGB, 24 bits/pixel
Mode 5	5	640 x 480, Y Mono, 8 bits/pixel
Mode 6	6	640 x 480, Y Mono, 16 bits/pixel
Mode x	7	Reserved for another mode
---	8 ... 31	Reserved

Register Name:		Video Mode Inquiry for Format 1
Offset from Base Address:		0x184
Field	**Bit**	**Description**
Mode 0	0	800 x 600, YUV 4:2:2, 16 bits/pixel
Mode 1	1	800 x 600, RGB, 24 bits/pixel
Mode 2	2	800 x 600, Y Mono, 8 bits/pixel
Mode 3	3	1024 x 768, YUV 4:2:2, 16 bits/pixel
Mode 4	4	1024 x 768, RGB, 24 bits/pixel
Mode 5	5	1024 x 768, Y Mono, 8 bits/pixel
Mode 6	6	800 x 600, Y Mono, 16 bits/pixel
Mode 7	7	1024 x 768, Y Mono, 16 bits/pixel
---	8 ... 31	Reserved

Register Name:		Video Mode Inquiry for Format 2
Offset from Base Address:		0x188
Field	**Bit**	**Description**
Mode 0	0	1280 x 960, YUV 4:2:2, 16 bits/pixel
Mode 1	1	1280 x 960, RGB, 24 bits/pixel
Mode 2	2	1280 x 960, Y Mono, 8 bits/pixel
Mode 3	3	1600 x 1200, YUV 4:2:2, 16 bits/pixel
Mode 4	4	1600 x 1200, RGB, 24 bits/pixel
Mode 5	5	1600 x 1200, Y Mono, 8 bits/pixel
Mode 6	6	1280 x 960, Y Mono, 16 bits/pixel
Mode 7	7	1600 x 1200, Y Mono, 16 bits/pixel
---	8 ... 31	Reserved

Register Name:		Video Mode Inquiry for Format 7
Offset from Base Address:		0x19C
Field	**Bit**	**Description**
Mode 0	0	Format 7, Mode 0
Mode 1	1	Format 7, Mode 1
Mode 2	2	Format 7, Mode 2
Mode 3	3	Format 7, Mode 3
Mode 4	4	Format 7, Mode 4
Mode 5	5	Format 7, Mode 5
Mode 6	6	Format 7, Mode 6
Mode 7	7	Format 7, Mode 7
---	8 ... 31	Reserved

11.1.4 Inquiry Registers for Video Frame Rates

Each bit in the video frame rates inquiry register indicates the availability of a specific video format, mode, frame rate combination (e.g., Format 0, Mode 0, Frame Rate 0).

0 = format not available 1 = format available

Register Name:		Video Frame Rate Inquiry for Format 0, Mode 0 (160 x 120, YUV 4:4:4, 24 bits/pixel)
Offset from Base Address:		0x200
Field	**Bit**	**Description**
---	0	Reserved
---	1	Reserved
Frame Rate 2	2	7.5 fps standard frame rate
Frame Rate 3	3	15 fps standard frame rate
Frame Rate 4	4	30 fps standard frame rate
Frame Rate 5	5	60 fps standard frame rate
Frame Rate 6	6	120 fps standard frame rate
Frame Rate 7	7	240 fps standard frame rate
---	8 ... 31	Reserved

Register Name:		Video Frame Rate Inquiry for Format 0, Mode 1 (320 x 240, YUV 4:2:2, 16 bits/pixel)
Offset from Base Address:		0x204
Field	**Bit**	**Description**
Frame Rate 0	0	1.875 fps standard frame rate
Frame Rate 1	1	3.75 fps standard frame rate
Frame Rate 2	2	7.5 fps standard frame rate
Frame Rate 3	3	15 fps standard frame rate
Frame Rate 4	4	30 fps standard frame rate
Frame Rate 5	5	60 fps standard frame rate
Frame Rate 6	6	120 fps standard frame rate
Frame Rate 7	7	240 fps standard frame rate
---	8 ... 31	Reserved

Register Name:		Video Frame Rate Inquiry for Format 0, Mode 2 (640 x 480, YUV 4:1:1, 12 bits/pixel)
Offset from Base Address:		0x208
Field	**Bit**	**Description**
Frame Rate 0	0	1.875 fps standard frame rate
Frame Rate 1	1	3.75 fps standard frame rate
Frame Rate 2	2	7.5 fps standard frame rate
Frame Rate 3	3	15 fps standard frame rate
Frame Rate 4	4	30 fps standard frame rate
Frame Rate 5	5	60 fps standard frame rate
Frame Rate 6	6	120 fps standard frame rate
Frame Rate 7	7	240 fps standard frame rate
---	8 ... 31	Reserved

Register Name:		Video Frame Rate Inquiry for Format 0, Mode 3 (640 x 480, YUV 4:2:2, 16 bits/pixel)
Offset from Base Address:		0x20C
Field	**Bit**	**Description**
Frame Rate 0	0	1.875 fps standard frame rate
Frame Rate 1	1	3.75 fps standard frame rate
Frame Rate 2	2	7.5 fps standard frame rate
Frame Rate 3	3	15 fps standard frame rate
Frame Rate 4	4	30 fps standard frame rate
Frame Rate 5	5	60 fps standard frame rate
Frame Rate 6	6	120 fps standard frame rate
Frame Rate 7	7	240 fps standard frame rate
---	8 ... 31	Reserved

Register Name:		Video Frame Rate Inquiry for Format 0, Mode 4 (640 x 480, RGB, 24 bits/pixel)
Offset from Base Address:		0x210
Field	**Bit**	**Description**
Frame Rate 0	0	1.875 fps standard frame rate
Frame Rate 1	1	3.75 fps standard frame rate
Frame Rate 2	2	7.5 fps standard frame rate
Frame Rate 3	3	15 fps standard frame rate
Frame Rate 4	4	30 fps standard frame rate
Frame Rate 5	5	60 fps standard frame rate
Frame Rate 6	6	120 fps standard frame rate
Frame Rate 7	7	240 fps standard frame rate
---	8 ... 31	Reserved

Register Name:		Video Frame Rate Inquiry for Format 0, Mode 5 (640 x 480, Y Mono, 8 bits/pixel)
Offset from Base Address:		0x214
Field	**Bit**	**Description**
Frame Rate 0	0	1.875 fps standard frame rate
Frame Rate 1	1	3.75 fps standard frame rate
Frame Rate 2	2	7.5 fps standard frame rate
Frame Rate 3	3	15 fps standard frame rate
Frame Rate 4	4	30 fps standard frame rate
Frame Rate 5	5	60 fps standard frame rate
Frame Rate 6	6	120 fps standard frame rate
Frame Rate 7	7	240 fps standard frame rate
---	8 ... 31	Reserved

Register Name:		Video Frame Rate Inquiry for Format 0, Mode 6 (640 x 480, Y Mono, 16 bits/pixel)
Offset from Base Address:		0x218
Field	**Bit**	**Description**
Frame Rate 0	0	1.875 fps standard frame rate
Frame Rate 1	1	3.75 fps standard frame rate
Frame Rate 2	2	7.5 fps standard frame rate
Frame Rate 3	3	15 fps standard frame rate
Frame Rate 4	4	30 fps standard frame rate
Frame Rate 5	5	60 fps standard frame rate
Frame Rate 6	6	120 fps standard frame rate
Frame Rate 7	7	240 fps standard frame rate
---	8 ... 31	Reserved

Register Name:		Video Frame Rate Inquiry for Format 1, Mode 0 (800 x 600, YUV 4:2:2, 16 bits/pixel)
Offset from Base Address:		0x220
Field	**Bit**	**Description**
---	0	Reserved
Frame Rate 1	1	3.75 fps standard frame rate
Frame Rate 2	2	7.5 fps standard frame rate
Frame Rate 3	3	15 fps standard frame rate
Frame Rate 4	4	30 fps standard frame rate
Frame Rate 5	5	60 fps standard frame rate
Frame Rate 6	6	120 fps standard frame rate
Frame Rate 7	7	240 fps standard frame rate
---	8 ... 31	Reserved

Register Name:		Video Frame Rate Inquiry for Format 1, Mode 1 (800 x 600, RGB, 24 bits/pixel)
Offset from Base Address:		0x224
Field	**Bit**	**Description**
---	0	Reserved
---	1	Reserved
Frame Rate 2	2	7.5 fps standard frame rate
Frame Rate 3	3	15 fps standard frame rate
Frame Rate 4	4	30 fps standard frame rate
Frame Rate 5	5	60 fps standard frame rate
Frame Rate 6	6	120 fps standard frame rate
Frame Rate 7	7	240 fps standard frame rate
---	8 ... 31	Reserved

Register Name:		Video Frame Rate Inquiry for Format 1, Mode 2 (800 x 600, Y Mono, 8 bits/pixel)
Offset from Base Address:		0x228
Field	**Bit**	**Description**
---	0	Reserved
---	1	Reserved
Frame Rate 2	2	7.5 fps standard frame rate
Frame Rate 3	3	15 fps standard frame rate
Frame Rate 4	4	30 fps standard frame rate
Frame Rate 5	5	60 fps standard frame rate
Frame Rate 6	6	120 fps standard frame rate
Frame Rate 7	7	240 fps standard frame rate
---	8 ... 31	Reserved

Register Name:		Video Frame Rate Inquiry for Format 1, Mode 3 (1024 x 768, YUV 4:2:2, 16 bits/pixel)
Offset from Base Address:		0x22C
Field	**Bit**	**Description**
Frame Rate 0	0	1.875 fps standard frame rate
Frame Rate 1	1	3.75 fps standard frame rate
Frame Rate 2	2	7.5 fps standard frame rate
Frame Rate 3	3	15 fps standard frame rate
Frame Rate 4	4	30 fps standard frame rate
Frame Rate 5	5	60 fps standard frame rate
Frame Rate 6	6	120 fps standard frame rate
Frame Rate 7	7	240 fps standard frame rate
---	8 ... 31	Reserved

Register Name:		Video Frame Rate Inquiry for Format 1, Mode 4 (1024 x 768, RGB, 24 bits/pixel)
Offset from Base Address:		0x230
Field	**Bit**	**Description**
Frame Rate 0	0	1.875 fps standard frame rate
Frame Rate 1	1	3.75 fps standard frame rate
Frame Rate 2	2	7.5 fps standard frame rate
Frame Rate 3	3	15 fps standard frame rate
Frame Rate 4	4	30 fps standard frame rate
Frame Rate 5	5	60 fps standard frame rate
---	6	Reserved
---	7	Reserved
---	8 ... 31	Reserved

Register Name:		Video Frame Rate Inquiry for Format 1, Mode 5 (1024 x 768, Y Mono, 8 bits/pixel)
Offset from Base Address:		0x234
Field	**Bit**	**Description**
Frame Rate 0	0	1.875 fps standard frame rate
Frame Rate 1	1	3.75 fps standard frame rate
Frame Rate 2	2	7.5 fps standard frame rate
Frame Rate 3	3	15 fps standard frame rate
Frame Rate 4	4	30 fps standard frame rate
Frame Rate 5	5	60 fps standard frame rate
Frame Rate 6	6	120 fps standard frame rate
Frame Rate 7	7	240 fps standard frame rate
---	8 ... 31	Reserved

Register Name:		Video Frame Rate Inquiry for Format 1, Mode 6 (800 x 600, Y Mono, 16 bits/pixel)
Offset from Base Address:		0x238
Field	**Bit**	**Description**
---	0	Reserved
Frame Rate 1	1	3.75 fps standard frame rate
Frame Rate 2	2	7.5 fps standard frame rate
Frame Rate 3	3	15 fps standard frame rate
Frame Rate 4	4	30 fps standard frame rate
Frame Rate 5	5	60 fps standard frame rate
Frame Rate 6	6	120 fps standard frame rate
Frame Rate 7	7	240 fps standard frame rate
---	8 ... 31	Reserved

Register Name:		Video Frame Rate Inquiry for Format 1, Mode 7 (1024 x 768, Y Mono, 16 bits/pixel)
Offset from Base Address:		0x23C
Field	**Bit**	**Description**
Frame Rate 0	0	1.875 fps standard frame rate
Frame Rate 1	1	3.75 fps standard frame rate
Frame Rate 2	2	7.5 fps standard frame rate
Frame Rate 3	3	15 fps standard frame rate
Frame Rate 4	4	30 fps standard frame rate
Frame Rate 5	5	60 fps standard frame rate
Frame Rate 6	6	120 fps standard frame rate
Frame Rate 7	7	240 fps standard frame rate
---	8 ... 31	Reserved

Register Name:		Video Frame Rate Inquiry for Format 2, Mode 0 (1280 x 960, YUV 4:2:2, 16 bits/pixel)
Offset from Base Address:		0x240
Field	**Bit**	**Description**
Frame Rate 0	0	1.875 fps standard frame rate
Frame Rate 1	1	3.75 fps standard frame rate
Frame Rate 2	2	7.5 fps standard frame rate
Frame Rate 3	3	15 fps standard frame rate
Frame Rate 4	4	30 fps standard frame rate
Frame Rate 5	5	60 fps standard frame rate
---	6	Reserved
---	7	Reserved
---	8 ... 31	Reserved

Register Name:		Video Frame Rate Inquiry for Format 2, Mode 1 (1280 x 960, RGB, 24 bits/pixel)
Offset from Base Address:		0x244
Field	**Bit**	**Description**
Frame Rate 0	0	1.875 fps standard frame rate
Frame Rate 1	1	3.75 fps standard frame rate
Frame Rate 2	2	7.5 fps standard frame rate
Frame Rate 3	3	15 fps standard frame rate
Frame Rate 4	4	30 fps standard frame rate
Frame Rate 5	5	60 fps standard frame rate
---	6	Reserved
---	7	Reserved
---	8 ... 31	Reserved

Register Name:		Video Frame Rate Inquiry for Format 2, Mode 2 (1280 x 960, Y Mono, 8 bits/pixel)
Offset from Base Address:		0x248
Field	**Bit**	**Description**
Frame Rate 0	0	1.875 fps standard frame rate
Frame Rate 1	1	3.75 fps standard frame rate
Frame Rate 2	2	7.5 fps standard frame rate
Frame Rate 3	3	15 fps standard frame rate
Frame Rate 4	4	30 fps standard frame rate
Frame Rate 5	5	60 fps standard frame rate
Frame Rate 6	6	120 fps standard frame rate
---	7	Reserved
---	8 ... 31	Reserved

Register Name:		Video Frame Rate Inquiry for Format 2, Mode 3 (1600 x 1200, YUV 4:2:2, 16 bits/pixel)
Offset from Base Address:		0x24C
Field	**Bit**	**Description**
Frame Rate 0	0	1.875 fps standard frame rate
Frame Rate 1	1	3.75 fps standard frame rate
Frame Rate 2	2	7.5 fps standard frame rate
Frame Rate 3	3	15 fps standard frame rate
Frame Rate 4	4	30 fps standard frame rate
Frame Rate 5	5	60 fps standard frame rate
Frame Rate 6	6	Reserved
Frame Rate 7	7	Reserved
---	8 ... 31	Reserved

Register Name:		Video Frame Rate Inquiry for Format 2, Mode 4 (1600 x 1200, RGB, 24 bits/pixel)
Offset from Base Address:		0x250
Field	**Bit**	**Description**
Frame Rate 0	0	1.875 fps standard frame rate
Frame Rate 1	1	3.75 fps standard frame rate
Frame Rate 2	2	7.5 fps standard frame rate
Frame Rate 3	3	15 fps standard frame rate
Frame Rate 4	4	30 fps standard frame rate
---	5	Reserved
---	6	Reserved
---	7	Reserved
---	8 ... 31	Reserved

Register Name:		Video Frame Rate Inquiry for Format 2, Mode 5 (1600 x 1200, Y Mono, 8 bits/pixel)
Offset from Base Address:		0x254
Field	**Bit**	**Description**
Frame Rate 0	0	1.875 fps standard frame rate
Frame Rate 1	1	3.75 fps standard frame rate
Frame Rate 2	2	7.5 fps standard frame rate
Frame Rate 3	3	15 fps standard frame rate
Frame Rate 4	4	30 fps standard frame rate
Frame Rate 5	5	60 fps standard frame rate
Frame Rate 6	6	120 fps standard frame rate
---	7	Reserved
---	8 ... 31	Reserved

Register Name:		Video Frame Rate Inquiry for Format 2, Mode 6 (1280 x 960, Y Mono, 16 bits/pixel)
Offset from Base Address:		0x258
Field	**Bit**	**Description**
Frame Rate 0	0	1.875 fps standard frame rate
Frame Rate 1	1	3.75 fps standard frame rate
Frame Rate 2	2	7.5 fps standard frame rate
Frame Rate 3	3	15 fps standard frame rate
Frame Rate 4	4	30 fps standard frame rate
Frame Rate 5	5	60 fps standard frame rate
---	6	Reserved
---	7	Reserved
---	8 ... 31	Reserved

Register Name:		Video Frame Rate Inquiry for Format 2, Mode 7 (1600 x 1200, Y Mono, 16 bits/pixel)
Offset from Base Address:		0x25C
Field	**Bit**	**Description**
Frame Rate 0	0	1.875 fps standard frame rate
Frame Rate 1	1	3.75 fps standard frame rate
Frame Rate 2	2	7.5 fps standard frame rate
Frame Rate 3	3	15 fps standard frame rate
Frame Rate 4	4	30 fps standard frame rate
Frame Rate 5	5	60 fps standard frame rate
Frame Rate 6	6	Reserved
Frame Rate 7	7	Reserved
---	8 ... 31	Reserved

11.1.5 Inquiry Registers for Format 7 CSR Offsets

Register Name:		Video CSR Inquiry for Format 7, Mode 0
Offset from Base Address:		0x2E0
Field	**Bit**	**Description**
Mode 0	0 ... 31	Indicates the quadlet offset from the base address of the initial register space for the Format 7, Mode 0 Control and Status Register (CSR).

Register Name:		Video CSR Inquiry for Format 7, Mode 1
Offset from Base Address:		0x2E4
Field	**Bit**	**Description**
Mode 1	0 ... 31	Indicates the quadlet offset from the base address of the initial register space for the Format 7, Mode 1 Control and Status Register (CSR).

11.1.6 Inquiry Registers for Basic Functions

Each bit in the basic function inquiry register indicates the availability of a specific basic function.

0 = function not available 1 = function available

(The memory channel bits are an exception. Refer to the description below.)

Register Name:		Basic Function Inquiry
Offset from Base Address:		0x400
Field	**Bit**	**Description**
Advanced Feature Inq	0	Advanced (vendor unique) features availability
Vmode Error Status Inq	1	VMode Error Status register availability
Feature Control Error Status Register Inq	2	Feature Control Error Status register availability
Optional Function CSR Inq	3	Optional Function Control and Status register availability
---	4 ... 7	Reserved
1394b Mode Capability	8	IEEE 1394b capability
---	9 ... 15	Reserved
Camera Power Ctrl.	16	Power on/off capability
---	17 ... 18	Reserved
One Shot Inq	19	“One Shot” image capture mode availability
Multi Shot Inq	20	“Multi Shot” image capture mode availability
---	21 ... 27	Reserved
Memory Channels	28 ... 31	Indicates the maximum memory channel number available. If all of these bits are set to 0, the camera **does not** support memory channels.

11.1.7 Inquiry Registers for Feature Presence

Each bit in the feature presence inquiry registers indicates the availability of a camera feature or optional function. Note that changing the video format or video mode may change the availability of a feature.

0 = feature not available 1 = feature available

Register Name:		Feature High Inquiry
Offset from Base Address:		0x404
Field	**Bit**	**Description**
Brightness	0	Brightness control availability
Auto Exposure	1	Auto exposure control availability
Sharpness	2	Sharpness control availability
White Balance	3	White balance control availability
Hue	4	Hue control availability
Saturation	5	Saturation control availability
Gamma	6	Gamma control availability
Shutter	7	Shutter speed control availability
Gain	8	Gain control availability
Iris	9	Iris control availability
Focus	10	Focus control availability
Temperature	11	Temperature control availability
Trigger	12	Trigger control availability
Trigger Delay Control	13	Trigger delay control availability
White Shading	14	White shading control availability
Frame Rate	15	Frame rate prioritization control availability
---	16 ... 31	Reserved

Register Name:		Feature Low Inquiry
Offset from Base Address:		0x408
Field	**Bit**	**Description**
Zoom	0	Zoom control availability
Pan	1	Pan control availability
Tilt	2	Tilt control availability
Optical Filter	3	Optical filter control availability
---	4 ... 15	Reserved
Capture Size	16	Format 6 capture size availability
Capture Quality	17	Format 6 capture quality availability
---	18 ... 31	Reserved

Register Name:		Optional Function Inquiry
Offset from Base Address:		0x40C
Field	**Bit**	**Description**
---	0	Reserved
PIO	1	Parallel input/output control availability
SIO	2	Serial input/output control availability
Strobe Output	3	Strobe output control availability
---	4 ... 31	Reserved

Register Name:		Advanced Features Inquiry
Offset from Base Address:		0x480
Field	**Bit**	**Description**
Advanced Feature Quadlet Offset	0 ... 31	Indicates the quadlet offset from the base address of the initial register space for the advanced features Control and Status Registers (CSR).

Register Name:		PIO Control CSR Inquiry
Offset from Base Address:		0x484
Field	**Bit**	**Description**
PIO Control Quadlet Offset	0 ... 31	Indicates the quadlet offset from the base address of the initial register space for the PIO Control and Status Registers (CSR).

Register Name:		Strobe Output CSR Inquiry
Offset from Base Address:		0x48C
Field	**Bit**	**Description**
Strobe Output Quadlet Offset	0 ... 31	Indicates the quadlet offset from the base address of the initial register space for the strobe output Control and Status Registers (CSR).

11.1.8 Inquiry Registers for Feature Elements

The features element inquiry registers indicate the availability of elements, modes, maximum and minimum values for features. Note that changing the video format or video mode may change the availability of a feature element.

0 = element not available 1 = element available

Register Name:		Brightness Inquiry
Offset from Base Address:		0x500
Field	**Bit**	**Description**
Presence Inq	0	Brightness control feature is present
Abs Control Inq	1	Brightness can be set with an absolute value
---	2	Reserved
One Push Inq	3	One push auto mode is present
Read Out Inq	4	The brightness value can be read
On/Off Inq	5	Brightness control can be switched on/off
Auto Inq	6	A brightness auto control mode is present
Manual Inq	7	The brightness value can be set manually
Min Value	8 ... 19	Minimum value for brightness
Max Value	20 ... 31	Maximum value for brightness

Register Name:		White Balance Inquiry
Offset from Base Address:		0x50C
Field	**Bit**	**Description**
Presence Inq	0	White balance feature is present
Abs Control Inq	1	White balance can be set with an absolute value
---	2	Reserved
One Push Inq	3	One push auto mode is present
Read Out Inq	4	The white balance value can be read
On/Off Inq	5	White balance can be switched on/off
Auto Inq	6	A white balance auto control mode is present
Manual Inq	7	The white balance value can be set manually
Min Value	8 ... 19	Minimum value for white balance
Max Value	20 ... 31	Maximum value for balance

Register Name:		Gamma Inquiry
Offset from Base Address:		0x518
Field	**Bit**	**Description**
Presence Inq	0	Gamma feature is present
Abs Control Inq	1	Gamma can be set with an absolute value
---	2	Reserved
One Push Inq	3	One push auto mode is present
Read Out Inq	4	The gamma value can be read
On/Off Inq	5	Gamma can be switched on/off
Auto Inq	6	A gamma auto control mode is present
Manual Inq	7	The gamma value can be set manually
Min Value	8 ... 19	Minimum value for gamma
Max Value	20 ... 31	Maximum value for gamma

Register Name:		Shutter Inquiry
Offset from Base Address:		0x51C
Field	**Bit**	**Description**
Presence Inq	0	Shutter control feature is present
Abs Control Inq	1	Shutter can be set with an absolute value
---	2	Reserved
One Push Inq	3	One push auto mode is present
Read Out Inq	4	The shutter value can be read
On/Off Inq	5	Shutter control can be switched on/off
Auto Inq	6	A shutter auto control mode is present
Manual Inq	7	The shutter value can be set manually
Min Value	8 ... 19	Minimum value for shutter
Max Value	20 ... 31	Maximum value for shutter

Register Name:		Gain Inquiry
Offset from Base Address:		0x520
Field	**Bit**	**Description**
Presence Inq	0	Gain control feature is present
Abs Control Inq	1	Gain can be set with an absolute value
---	2	Reserved
One Push Inq	3	One push auto mode is present
Read Out Inq	4	The gain value can be read
On/Off Inq	5	Gain control can be switched on/off
Auto Inq	6	A gain auto control mode is present
Manual Inq	7	The gain value can be set manually
Min Value	8 ... 19	Minimum value for gain
Max Value	20 ... 31	Maximum value for gain

Register Name:		Trigger Inquiry
Offset from Base Address:		0x530
Field	Bit	Description
Presence Inq	0	Trigger control feature is present
Abs Control Inq	1	Trigger can be set with an absolute value
---	2 ... 3	Reserved
Read Out Inq	4	The trigger value can be read
On/Off Inq	5	Trigger control can be switched on/off
Polarity Inq	6	The trigger input polarity can be changed
Value Read	7	The raw trigger input can be read
Trigger Source 0 Inq	8	Trigger source 0 is present (ID = 0)
Trigger Source 1 Inq	9	Trigger source 1 is present (ID = 1)
Trigger Source 2 Inq	10	Trigger source 2 is present (ID = 2)
Trigger Source 3 Inq	11	Trigger source 3 is present (ID = 3)
---	12 ... 14	Reserved
Software Trigger Inq	15	Software trigger is present (ID = 7)
Trigger Mode 0 Inq	16	Trigger mode 0 is present
Trigger Mode 1 Inq	17	Trigger mode 1 is present
Trigger Mode 2 Inq	18	Trigger mode 2 is present
Trigger Mode 3 Inq	19	Trigger mode 3 is present
Trigger Mode 4 Inq	20	Trigger mode 4 is present
Trigger Mode 5 Inq	21	Trigger mode 5 is present
---	22 ... 29	Reserved
Trigger Mode 14 Inq	30	Trigger mode 14 is present (Vendor unique trigger mode 0)
Trigger Mode 15 Inq	31	Trigger mode 15 is present (Vendor unique trigger mode 1)

Register Name:		Frame Rate Inquiry
Offset from Base Address:		0x53c
Field	**Bit**	**Description**
Presence Inq	0	Frame rate control feature is present
Abs Control Inq	1	Frame rate can be set with an absolute value
---	2	Reserved
One Push Inq	3	One push auto mode is present
Read Out Inq	4	The frame rate value can be read
On/Off Inq	5	Frame rate control can be switched on/off
Auto Inq	6	A frame rate auto control mode is present
Manual Inq	7	The frame rate value can be set manually
Min Value	8 ... 19	Minimum value for frame rate
Max Value	20 ... 31	Maximum value for frame rate

11.2 Control and Status Registers

The base address for all camera control and status registers is:

Bus ID, Node ID, FFFF F0F0 0000

In each control and status register description, an “Offset from the Base Address” is provided. This a byte offset from the above base address. The address of a control and status register equals the above base address plus the indicated offset.

Values are stated in decimal format except when marked 0x. Values marked as 0x (e.g., 0x123) are in hexadecimal format. **Bit 0 in each register is the most significant bit.**

11.2.1 Control and Status Registers for Basic Camera Operation

Register Name:		Current Video Frame Rate / Revision
Offset from Base Address:		0x600
Field	**Bit**	**Description**
Frame Rate / Revision	0 ... 2	If a camera is set for video Format 0, 1 or 2, this field sets the current video frame rate. 0 = frame rate 0 4 = frame rate 4 1 = frame rate 1 5 = frame rate 5 2 = frame rate 2 6 = frame rate 6 3 = frame rate 3 7 = frame rate 7 If the camera is set for Format 7, the setting in this field is ignored. If the camera is set for Format 6, this field sets the current revision.
---	3 ... 31	Reserved

Register Name:		Current Video Mode
Offset from Base Address:		0x604
Field	**Bit**	**Description**
Mode	0 ... 2	This field sets the current video mode. 0 = mode 0 4 = mode 4 1 = mode 1 5 = mode 5 2 = mode 2 6 = mode 6 3 = mode 3 7 = mode 7
---	3 ... 31	Reserved

Register Name:		Current Video Format
Offset from Base Address:		0x608
Field	**Bit**	**Description**
Format	0 ... 2	This field sets the current video format. 0 = format 0 6 = format 6 1 = format 1 7 = format 7 2 = format 2
---	3 ... 31	Reserved

Register Name:		ISO
Offset from Base Address:		0x60C
Field	**Bit**	**Description**
ISO Channel L	0 ... 3	Sets the isochronous channel number for video transmission for the legacy mode. 0 = channel 0 6 = channel 6 11 = channel 11 1 = channel 1 7 = channel 7 12 = channel 12 2 = channel 2 8 = channel 8 13 = channel 13 3 = channel 3 9 = channel 9 14 = channel 14 4 = channel 4 10 = channel 10 15 = channel 15 5 = channel 5
---	4 ... 5	Reserved
Iso Speed L	6 ... 7	Sets the isochronous transmit speed code for the legacy mode. 0 = 100 M 1 = 200 M 2 = 400 M
---	8 ... 15	Reserved
Operation Mode	16	Sets the 1394 operation mode. 0 = Legacy 1 = 1394b
---	17	Reserved
Iso Channel B	18 ... 23	Isochronous channel number for video data transmission in 1394b mode.
---	24 ... 28	Reserved
Iso Speed B	29 ... 31	Isochronous transmit speed code for 1394b mode. 0 = 100 M 1 = 200 M 2 = 400 M 3 = 800 M 4 = 1.6 G 5 = 3.2G

Register Name:		ISO EN / Continuous Shot
Offset from Base Address:		0x614
Field	**Bit**	**Description**
Continuous Shot	0	When the camera is set for video Format 0 or Format 7, this field controls the “continuous shot” video transmission mode. 1 = start “continuous shot” transmission 0 = stop “continuous shot” transmission
---	1 ... 31	Reserved

Register Name:		Memory Save
Offset from Base Address:		0x618
Field	**Bit**	**Description**
Save	0	Writing a 1 to this field will cause the current settings in the work configuration set to be saved to the memory channel specified in the Memory Save Channel register. (This register self clears.)
---	1 ... 31	Reserved

Register Name:		One Shot / Multi Shot
Offset from Base Address:		0x61C
Field	**Bit**	**Description**
One Shot	0	When the camera is set for video Format 0 or Format 7, this field controls the “one shot” video transmission mode. 1 = transmit one frame of video data (Field is self cleared after transmission.)
Multi Shot	1	Not supported.
---	2 ... 15	Reserved
Count Number	16 ... 31	Not supported.

Register Name:		Memory Save Channel
Offset from Base Address:		0x620
Field	**Bit**	**Description**
Save Channel	0 ... 3	When a 1 is written to the Memory Save register, the current settings in the work configuration set will be saved to the memory channel specified in this register.
---	4 ... 31	Reserved

Register Name:		Current Memory Channel
Offset from Base Address:		0x624
Field	**Bit**	**Description**
Current Channel	0	Writing a value to this field will cause the settings saved in the specified memory channel to be copied into the work configuration set. Reading the value from this register will indicate the last memory channel that was copied into the work configuration set.
---	1 ... 31	Reserved

Register Name:		VMode Error Status
Offset from Base Address:		0x628
Field	**Bit**	**Description**
Status	0	Used only when the camera is set for a standard format (not Format 7). This field will be updated each time the video format, mode, frame rate or ISO speed setting is changed. The value in this field indicates whether the current combination of video format, mode, frame rate and ISO speed settings is acceptable to the camera. 0 = the combination is OK, image capture can be started 1 = the combination is not OK, image capture can not be started This field is read only.
---	1 ... 31	Reserved

Register Name:		Software Trigger
Offset from Base Address:		0x62C
Field	**Bit**	**Description**
Trigger	0	When the Trigger Source field of the Trigger Mode register is set for a software trigger, this field controls the software trigger. 0 = reset the software trigger 1 = set the software trigger (If the Trigger Mode field of the Trigger Mode register is set to 0, this field will self clear.)
---	1 ... 31	Reserved

Register Name:		Data Depth
Offset from Base Address:		0x630
Field	**Bit**	**Description**
Depth	0 ... 7	Indicates the effective depth of the data in the transmitted images. Depends on the current format and mode settings. Also depends on the Color Coding ID if the camera is set for Format 7. This field is read only. Camera set for: — Effective data depth indicated: Mono 8 — 8 bits/pixel Mono 12 Packed — 12 bits/pixel Mono 16 — 12 bits/pixel Raw 8 — 8 bits/pixel Raw 12 Packed — 12 bits/pixel Raw 16 — 12 bits/pixel 4:2:2 YUV — 8 bits/component 4:2:2 YUV (YUYV) — 8 bits/component
---	8 ... 31	Reserved

11.2.2 Control and Status Registers for Features

Register Name:		Brightness
Offset from Base Address:		0x800
Field	**Bit**	**Description**
Presence Inq	0	Indicates the presence of the brightness control feature. 0 = not present 1 = present This field is read only.
Abs Control	1	Determines whether the brightness will be controlled by the Value field of this register or by the Absolute Value CSR for brightness. 0 = control with the value in the Value field 1 = control with the value in the Absolute Value CSR If this bit is 1, the value in the Value field will be ignored Since the Absolute Value CSR is not implemented on this camera, this field is read only.
---	2 ... 4	Reserved
One Push	5	Sets “One Push” operation. 0 = not in operation 1 = in operation If A / M Mode is 1, this field will be ignored This field is read only.
On / Off	6	Sets whether brightness control is on or off. 0 = off 1 = on If this bit is 0, all other fields will be read only This field is read only.
A / M Mode	7	Sets whether the camera is in automatic or manual brightness control mode. 0 = manual 1 = automatic This field is read only.
---	8 ... 19	Reserved
Value	20 ... 31	Sets the brightness.

Register Name:		White Balance
Offset from Base Address:		0x80C
Field	**Bit**	**Description**
Presence Inq	0	Indicates the presence of the white balance control feature. 0 = not present 1 = present This field is read only.
Abs Control	1	Determines whether the white balance will be controlled by the Value field of this register or by the Absolute Value CSR for white balance. 0 = control with the value in the Value field 1 = control with the value in the Absolute Value CSR If this bit is 1, the value in the Value field will be ignored Since the Absolute Value CSR is not implemented on this camera, this field is read only.
---	2 ... 4	Reserved
One Push	5	Sets “One Push” operation. 0 = not in operation 1 = in operation If A / M Mode is 1, this field will be ignored This field is read only.
On / Off	6	Sets whether white balance control is on or off. 0 = off 1 = on If this bit is 0, all other fields will be read only This field is read only.
A / M Mode	7	Sets whether the camera is in automatic or manual white balance control mode. 0 = manual 1 = automatic This field is read only.
Blue Value	8 ... 19	Adjusts the blue level in the captured images.
Red Value	20 ... 31	Adjusts the red level in the captured images.

Register Name:		Gamma
Offset from Base Address:		0x818
Field	**Bit**	**Description**
Presence Inq	0	Indicates the presence of the gamma feature. 0 = not present 1 = present This field is read only.
Abs Control	1	Determines whether gamma will be controlled by the Value field of this register or by the Absolute Value CSR for gamma. 0 = control with the value in the Value field 1 = control with the value in the Absolute Value CSR If this bit is 1, the value in the Value field will be ignored Since the Absolute Value CSR is not implemented on this camera, this field is read only.
---	2 ... 4	Reserved
One Push	5	Sets “One Push” operation. 0 = not in operation 1 = in operation If A / M Mode is 1, this field will be ignored This field is read only.
On / Off	6	Sets whether gamma is on or off. 0 = off 1 = on If this bit is 0, all other fields will be read only This field is read only.
A / M Mode	7	Sets whether the camera is in automatic or manual gamma mode. 0 = manual 1 = automatic This field is read only.
---	8 ... 19	Reserved
Value	20 ... 31	Sets the gamma.

Register Name:		Shutter
Offset from Base Address:		0x81C
Field	**Bit**	**Description**
Presence Inq	0	Indicates the presence of the shutter control feature. 0 = not present 1 = present This field is read only.
Abs Control	1	Determines whether the shutter will be controlled by the Value field of this register or by the Absolute Value CSR for the shutter. 0 = control with the value in the Value field 1 = control with the value in the Absolute Value CSR If this bit is 1, the value in the Value field will be ignored Since the Absolute Value CSR is not implemented on this camera, this field is read only.
---	2 ... 4	Reserved
One Push	5	Sets “One Push” operation. 0 = not in operation 1 = in operation If A / M Mode is 1, this field will be ignored This field is read only.
On / Off	6	Sets whether shutter control is on or off. 0 = off 1 = on If this bit is 0, all other fields will be read only This field is read only.
A / M Mode	7	Sets whether the camera is in automatic or manual shutter control mode. 0 = manual 1 = automatic This field is read only.
---	8 ... 19	Reserved
Value	20 ... 31	Sets the shutter value.

Register Name:		Gain
Offset from Base Address:		0x820
Field	**Bit**	**Description**
Presence Inq	0	Indicates the presence of the gain control feature. 0 = not present 1 = present This field is read only.
Abs Control	1	Determines whether the gain will be controlled by the Value field of this register or by the Absolute Value CSR for gain. 0 = control with the value in the Value field 1 = control with the value in the Absolute Value CSR If this bit is 1, the value in the Value field will be ignored Since the Absolute Value CSR is not implemented on this camera, this field is read only.
---	2 ... 4	Reserved
One Push	5	Sets “One Push” operation. 0 = not in operation 1 = in operation If A / M Mode is 1, this field will be ignored This field is read only.
On / Off	6	Sets whether gain control is on or off. 0 = off 1 = on If this bit is 0, all other fields will be read only This field is read only.
A / M Mode	7	Sets whether the camera is in automatic or manual gain control mode. 0 = manual 1 = automatic This field is read only.
---	8 ... 19	Reserved
Value	20 ... 31	Sets the gain.

Register Name:		Trigger Mode
Offset from Base Address:		0x830
Field	**Bit**	**Description**
Presence Inq	0	Indicates the presence of the trigger mode control feature. 0 = not present 1 = present This field is read only.
Abs Control	1	Determines whether the trigger mode will be controlled by the Value field of this register or by the Absolute Value CSR for the trigger mode. 0 = control with the value in the Value field 1 = control with the value in the Absolute Value CSR If this bit is 1, the value in the Value field will be ignored Since the Absolute Value CSR is not implemented on this camera, this field is read only.
---	2 ... 5	Reserved
On / Off	6	Sets whether trigger mode control is on or off. 0 = off 1 = on If this bit is 0, all other fields will be read only
Trigger Polarity	7	Sets the trigger polarity when the camera is using a hardware trigger. 0 = low active input 1 = high active input
Trigger Source	8 ... 10	Sets the trigger source. 0 = External trigger signal applied to physical input port 0 1 = External trigger signal applied to physical input port 1 7 = Software trigger
Trigger Value	11	Not used. This bit should be ignored.
Trigger Mode	12 ... 15	Sets the trigger mode. 0 = mode 0 (programmable mode) 1 = mode 1 (level mode) When an external trigger signal is used, mode 0 and mode 1 are both valid. When a software trigger is used, only mode 0 is valid.
---	16 ... 19	Reserved
Parameter	20 ... 31	Not used.

Register Name:		Frame Rate
Offset from Base Address:		0x83c
Field	**Bit**	**Description**
Presence Inq	0	Indicates the presence of the frame rate control feature. 0 = not present 1 = present This field is read only.
Abs Control	1	Determines whether the frame rate will be controlled by the Value field of this register or by the Absolute Value CSR for the frame rate. 0 = control with the value in the Value field 1 = control with the value in the Absolute Value CSR If this bit is 1, the value in the Value field will be ignored Since the Absolute Value CSR is not implemented on this camera, this field is read only.
---	2 ... 4	Reserved
One Push	5	Sets “One Push” operation. 0 = not in operation 1 = in operation If A / M Mode is 1, this field will be ignored This field is read only.
On / Off	6	Sets whether frame rate control is on or off. 0 = off 1 = on Frame rate control will only work when the camera is set for video format 7.
A / M Mode	7	Sets whether the camera is in automatic or manual frame rate control. 0 = manual 1 = automatic This field is read only.
---	8 ... 19	Reserved
Value	20 ... 31	When the camera is set for video format 7, the frame rate value can be used to set the camera for a specific frame rate. The frame rate value setting will only be effective if it is lower than the frame rate determined by the exposure time and bytes per packet settings. The value of the frame rate setting can range from 1 to 4095. The actual frame rate can be calculated by dividing the value of the setting by ten. Example: A frame rate setting of 4095 equals a frame rate of 409.5 fps. The frame rate value can only be modified if the On/Off field of this register is set to 1.

11.2.3 Error Status Registers for Feature Control

As defined in the IIDC specification, each field in this register is an error or warning flag for the corresponding feature control register. If a bit = 1, the mode and/or value of the corresponding feature control register has an error or warning. If a bit = 0, no error or warning is present. Each field in this register will be updated whenever the corresponding feature control register is updated. If a bit = 1, we strongly recommend checking the corresponding control register.

Usually, a feature's bit will become 1 when the feature's setting is outside the specified range of allowed settings, that is, the setting is lower than the allowed minimum or higher than the allowed maximum. If this situation occurs, the camera will continue image capture and you will see the undesired effects that result from the erroneous setting.

Register Name:		Feature Control Error Status High
Offset from Base Address:		0x640
Field	**Bit**	**Description**
Brightness	0	Indicates a brightness control error on the camera. 0 = no error present 1 = a setting in the brightness control register is outside of the allowed range This field is read only.
Auto Exposure	1	Not used
Sharpness	2	Not used
White Balance	3	Indicates a white balance control error on a color camera. 0 = no error present 1 = a setting in the white balance control register is outside of the allowed range This field is read only.
Hue	4	Not used
Saturation	5	Not used
Gamma	6	Not used
Shutter	7	Indicates a shutter control error on the camera. 0 = no error present 1 = a setting in the shutter control register is outside of the allowed range This field is read only.
Gain	8	Indicates a gain control error on the camera. 0 = no error present 1 = a setting in the gain control register is outside of the allowed range This field is read only.
Iris	9	Not used
Focus	10	Not used
Temperature	11	Not used

Field	Bit	Description
Trigger	12	Indicates a trigger mode control error on the camera. 0 = no error present 1 = a setting in the trigger mode control register is outside of the allowed range This field is read only.
Trigger Delay	13	Not used
White Shading	14	Not used
Frame Rate	15	Not used
---	16 ... 31	Reserved

Register Name:		Feature Control Error Status Low
Offset from Base Address:		0x644
Field	**Bit**	**Description**
Zoom	0	Not used
Pan	1	Not used
Tilt	2	Not used
Optical Filter	3	Not used
---	4 ... 15	Reserved
Capture Size	16	Not used
Capture Quality	17	Not used
---	18 ... 31	Reserved

11.2.4 Control & Status Registers for Format 7, Mode 0

Format 7, Mode 0 is available on all cameras. The base address for each Format 7, Mode 0 camera control register is:

Bus ID, Node ID, FFFF F1F0 0000

In each Format 7, Mode 0 register description, an “Offset from the Base Address” is provided. This is a byte offset from the above base address. The address of a Format 7, Mode 0 register equals the above base address plus the indicated offset.

Values are stated in decimal format except when marked 0x. Values marked as 0x (e.g., 0x123) are in hexadecimal format. Bit 0 in each register is the most significant bit.

Register Name:		Max Image Size Inquiry
Offset from Base Address:		0x000
Field	**Bit**	**Description**
Hmax	0 ... 15	Indicates the maximum horizontal image size in pixels.
Vmax	16 ... 31	Indicates the maximum vertical image size in pixels.

Register Name:		Unit Size Inquiry
Offset from Base Address:		0x004
Field	**Bit**	**Description**
Hunit	0 ... 15	Indicates the increment in columns for adjusting the area of interest width. For example, if the Hunit is 2, the width should be set in increments of 2.
Vunit	16 ... 31	Indicates the increment in rows for adjusting the area of interest height. For example, if the Vunit is 2, the height should be set in increments of 2.

Register Name:		Image Position
Offset from Base Address:		0x008
Field Name:	**Bit**	**Description**
Left	0 ... 15	Sets the left (starting) column of pixels for the area of interest.
Top	16 ... 31	Sets the top row of pixels for the area of interest.

Register Name:		Image Size
Offset from Base Address:		0x00C
Field	**Bit**	**Description**
Width	0 ... 15	Sets the width in columns for the area of interest.
Height	16 ... 31	Sets the height in rows for the area of interest.

Register Name:		Color Coding ID
Offset from Base Address:		0x010
Field	**Bit**	**Description**
Coding ID	0 ... 7	Sets the color coding. Valid color codings for Format 7 Mode 0 are listed in the Color Coding Inquiry registers (see the next register descriptions).
---	8 ... 31	Reserved

Register Name:		Color Coding Inquiry
Offset from Base Address:		0x014
Field Name:	**Bit**	**Description**
Mono 8	0	Y only, 8 bits, non-compressed (ID = 0) 0 = does not support 1 = does support
4:1:1 YUV8	1	4:4:1 YUV, 8 bits/component, non-compressed (ID = 1) 0 = does not support 1 = does support
4:2:2 YUV 8	2	4:2:2 YUV, 8 bits/component, non-compressed (ID = 2) 0 = does not support 1 = does support
4:4:4 YUV 8	3	4:4:4 YUV, 8 bits/component, non-compressed (ID = 3) 0 = does not support 1 = does support
RGB 8	4	RGB, 8 bits/component, non-compressed (ID = 4) 0 = does not support 1 = does support
Mono 16	5	Y only, 16 bits, non-compressed (unsigned integer) (ID = 5) 0 = does not support 1 = does support
RGB 16	6	RGB, 16 bits/component, non-compressed (unsigned integer) (ID = 6) 0 = does not support 1 = does support
Signed Mono 16	7	Y only, 16 bits, non-compressed (signed integer) (ID = 7) 0 = does not support 1 = does support
Signed RGB 16	8	RGB, 16 bits/component, non-compressed (signed integer) (ID = 8) 0 = does not support 1 = does support
Raw 8	9	8 bit, raw data output from a color filter sensor (ID = 9) 0 = does not support 1 = does support
Raw 16	10	16 bit, raw data output from a color filter sensor (ID = 10) 0 = does not support 1 = does support
---	11 ... 31	Reserved

Register Name:		Color Coding Inquiry
Offset from Base Address:		0x024
Field Name:	**Bit**	**Description**
---	0 ... 4	Reserved
YUV 4:2:2 (YUYV)	5	Vendor specific color coding (ID=133) YUV 4:2:2 (YUYV), 8 bits/component, non-compressed 0 = does not support 1 = does support
Mono 12 Packed	6	Vendor specific color coding (ID=134) Mono 12 Packed, 12 bits/pixel, packed 0 = does not support 1 = does support
Raw 12 Packed	7	Vendor specific color coding (ID=135) Raw 12 Packed, 12 bits/pixel, packed 0 = does not support 1 = does support
---	8 ... 31	Reserved

Register Name:		Pixel Number Inquiry
Offset from Base Address:		0x034
Field	**Bit**	**Description**
Pixels Per Frame	0 ... 31	Indicates the total number of pixels per frame. The value in this register depends on settings in the Format 7, Mode 0 Image Size register.

Register Name:		Total Bytes High Inquiry
Offset from Base Address:		0x038
Field	**Bit**	**Description**
Bytes Per Frame High	0 ... 31	Indicates the higher quadlet of the total bytes of image data per frame. The value in this register depends on settings in the Format 7, Mode 0 Image Size and Color Coding ID registers. The value in this register includes image data, padding bytes and any data added by any enabled reporting smart features.

Register Name:		Total Bytes Low Inquiry
Offset from Base Address:		0x03C
Field	**Bit**	**Description**
Bytes Per Frame Low	0 ... 31	Indicates the lower quadlet of the total bytes of image data per frame. The value in this register depends on settings in the Format 7, Mode 0 Image Size and Color Coding ID registers. The value in this register includes image data, padding bytes and any data added by any enabled smart features.

Register Name:		Packet Para Inquiry
Offset from Base Address:		0x040
Field	**Bit**	**Description**
Unit Bytes Per Packet	0 ... 15	Indicates the increment for setting the Bytes Per Packet field of the Bytes Per Packet register.
Max Bytes Per Packet	16 ... 31	Indicates the maximum setting for the Bytes Per Packet field of the Bytes Per Packet register.

Register Name:		Bytes Per Packet
Offset from Base Address:		0x044
Field	**Bit**	**Description**
Bytes Per Packet	0 ... 15	Sets the number of bytes per packet (the packet size). **Note:** When you lower the bytes per packet setting, the number of packets needed to transmit a frame (the packets per frame) will increase.
Rec Byte Per Packet	16 ... 31	Indicates the minimum bytes per packet needed to achieve the highest possible frame rate with the current camera settings. The recommended bytes per packet field is updated whenever the Format 7 settings are changed.

Register Name:		Packets Per Frame Inquiry
Offset from Base Address:		0x048
Field	**Bit**	**Description**
Packets Per Frame	0 ... 31	Indicates the total packets per frame. The value in this register depends on settings in the Format 7, Mode 0 Image Size and Color Coding ID registers and on the setting in the Format 7, Mode 0 Bytes per Packet register (see above). The value in this register includes image data, padding bytes and any data added by any enabled smart features.

Register Name:		Unit Position Inquiry
Offset from Base Address:		0x04C
Field	**Bit**	**Description**
Hposunit	0 ... 15	Indicates the increment in columns for adjusting the area of interest starting column. For example, if the Hposunit is 1, the starting column should be adjusted in increments of 1.
Vposunit	16 ... 31	Indicates the increment in rows for adjusting the area of interest starting row. For example, if the Vposunit is 1, the starting row should be adjusted in increments of 1.

Register Name:		Frame Interval Inquiry
Offset from Base Address:		0x050
Field	**Bit**	**Description**
Frame Interval	0 ... 31	Indicates the current frame period in seconds. This value will be updated when you adjust any register that affects the frame period. The value in this register is a standard IEEE-754 single precision (32 bit) floating point number.

Register Name:		Data Depth Inquiry
Offset from Base Address:		0x054
Field	**Bit**	**Description**
Data Depth	0 ... 7	Indicates the effective depth of the data in the transmitted images. The value in this register depends on the setting in the Format 7, Mode 0 Color Coding ID register. This field is read only. Color Coding ID setting: — Effective data depth indicated: ID = 0 (Mono 8) — 8 bits/pixel ID = 2 (YUV 4:2:2) — 8 bits/component ID = 5 (Mono 16) — 12 bits/pixel ID = 9 (Raw 8) — 8 bits/pixel ID = 10 (Raw 16) — 12 bits/pixel ID = 133 (YUV 4:2:2 (YUYV)) — 8 bits/component ID = 134 (Mono 12 Packed) — 12 bits/pixel ID = 135 (Raw 12 Packed) — 12 bits/pixel
---	8 ... 31	Reserved

Register Name:		Color Filter ID
Offset from Base Address:		0x058
Field	**Bit**	**Description**
Filter ID	0 ... 7	Indicates the alignment of the camera's color filter to the current AOI. This field is valid for cameras equipped with a Bayer RGB primary color filter. Value in this field: Pixel color order: 0 RG/GB 1 GB/RG 2 GR/BG 3 BG/GR
---	8 ... 31	Reserved

Register Name:		Value Setting
Offset from Base Address:		0x07C
Field	**Bit**	**Description**
Presence Inq	0	Indicates whether the fields in this register are valid. 0 = not valid 1 = valid The Presence Inq field is read only.
Setting 1	1	Not used
---	2 ... 7	Reserved
Error Flag 1	8	Indicates whether the combination of the values in the ISO Speed register and in the Format 7 Mode 0 Image Position, Image Size and Color Coding ID registers is acceptable. 0 = acceptable 1 = not acceptable and no image capture can be started
Error Flag 2	9	Indicates whether the value in the Bytes per Packet register is acceptable. 0 = acceptable 1 = not acceptable and no image capture can be started This field is updated whenever a value is written in the Bytes per Packet register.
---	10 ... 31	Reserved

11.2.5 Control and Status Registers for the PIO Control Function

The base address for the PIO Control Function control and status registers is:

Bus ID, Node ID, FFFF F2F0 00C8

In each PIO register description, an “Offset the from Base Address” is provided. This is a byte offset from the above base address. The address of a PIO register equals the above base address plus the indicated offset.

Values are stated in decimal format except when marked 0x. Values marked as 0x (e.g., 0x123) are in hexadecimal format. Bit 0 in each register is the most significant bit.

Register Name:		PIO Output
Offset from Base Address:		0x000
Field	**Bit**	**Description**
---	0 ... 27	Reserved
Port 3 Out	28	Sets the state of physical output port 3. 0 = low 1 = high
Port 2 Out	29	Sets the state of physical output port 2. 0 = low 1 = high
Port 1 Out	30	Sets the state of physical output port 1. 0 = low 1 = high
Port 0 Out	31	Sets the state of physical output port 0. 0 = low 1 = high

Note

The PIO Output register can only set the state of a physical output port if that port is configured as user settable. For any output port not configured as user settable, the bit setting in the PIO Output register will be ignored.

Register Name:		PIO Input
Offset from Base Address:		0x004
Field	**Bit**	**Description**
---	0 ... 27	Reserved
Port 3 In	28	Not used
Port 2 In	29	Not used
Port 1 In	30	Indicates the current state of physical input port 1. 0 = low 1 = high
Port 0 In	31	Indicates the current state of physical input port 0. 0 = low 1 = high

11.2.6 Control and Status Registers for the Strobe Signal Function

The base address for the Strobe Signal control and status registers is:

Bus ID, Node ID, FFFF F2F0 0300

In each Strobe Signal register description, an “Offset from the Base Address” is provided. This a byte offset from the above base address. The address of a strobe signal register equals the above base address plus the indicated offset.

Values are stated in decimal format except when marked 0x. Values marked as 0x (e.g., 0x123) are in hexadecimal format. Bit 0 in each register is the most significant bit.

Register Name:		Strobe Control Inquiry
Offset from Base Address:		0x000
Field	**Bit**	**Description**
Strobe 0 Inq	0	Presence of the Strobe 0 signal feature 0 = not present 1 = present
Strobe 1 Inq	1	Presence of the Strobe 1 signal feature 0 = not present 1 = present
Strobe 2 Inq	2	Presence of the Strobe 2 signal feature 0 = not present 1 = present
Strobe 3 Inq	3	Presence of the Strobe 3 signal feature 0 = not present 1 = present
---.	4 ... 31	Reserved

Register Name:		Strobe 0 Inquiry
Offset from Base Address:		0x100
Field	**Bit**	**Description**
Presence Inq	0	Strobe 0 signal feature is present 0 = not present 1 = present
---	1 ... 3	Reserved
Read Out Inq	4	The Strobe 0 value can be read 0 = no 1 = yes
On/Off Inq	5	Strobe 0 control can be switched on/off 0 = no 1 = yes
Polarity Inq	6	Strobe 0 polarity can be changed 0 = no 1 = yes
---.	7	Reserved
Min Value	8 ... 19	Minimum value for Strobe 0 controls
Max Value	20 ... 31	Maximum value for Strobe 0 controls

Register Name:		Strobe 1 Inquiry
Offset from Base Address:		0x104
Field	**Bit**	**Description**
Same definitions and values as Strobe 0 Inq		

Register Name:		Strobe 2 Inquiry
Offset from Base Address:		0x108
Field	**Bit**	**Description**
Same definitions and values as Strobe 0 Inq		

Register Name:		Strobe 3 Inquiry
Offset from Base Address:		0x10C
Field	**Bit**	**Description**
Same definitions and values as Strobe 0 Inq		

Register Name:		Strobe 0 Control
Offset from Base Address:		0x200
Field	**Bit**	**Description**
Presence Inq	0	Indicates the presence of the Strobe 0 signal control feature. 0 = not available 1 = available This field is read only.
---	1 ... 5	Reserved
On / Off	6	Sets whether the Strobe 0 signal is on or off. 0 = off 1 = on If this bit is 0, all other fields in this register are read only.
Signal Polarity	7	Sets the polarity of the Strobe 0 signal. 0 = low active 1 = high active
Delay Value	8 ... 19	Sets the delay value for the Strobe 0 signal. The delay value can range from 0 to 4095. Strobe 0 Delay = (Delay Value Setting) x (Delay Time Base)
Duration Value	20 ... 31	Sets the duration value for the Strobe 0 signal. The duration value can range from 0 to 4095. Strobe 0 Duration = (Dur. Value Setting) x (Duration Time Base)

Register Name:		Strobe 1 Control
Offset from Base Address:		0x204
Field	**Bit**	**Description**
Same definitions and values as Strobe 0 Control.		

Register Name:		Strobe 2 Control
Offset from Base Address:		0x208
Field	**Bit**	**Description**
Same definitions and values as Strobe 0 Control.		

Register Name:		Strobe 3 Control
Offset from Base Address:		0x20C
Field	**Bit**	**Description**
Same definitions and values as Strobe 0 Control.		

Note

If a strobe signal is on, the signal will only be present on the associated output port if the output port is configured for “strobe.” For example, if the Strobe 0 signal is on, the signal will only be present on physical output port 0 if the port is configured for “strobe”. If the Strobe 1 signal is on, the signal will only be present on physical output port 1 if the port is configured for “strobe”. Etc.

11.2.7 Advanced Feature Registers

The base address for all advanced features registers is:

Bus ID, Node ID, FFFF F2F0 0000

The first eight quadlets of the advanced features register space is designated as the advanced features “Access Control Register” as described in the table below.

Values are stated in decimal format except when marked 0x. Values marked as 0x (e.g., 0x123) are in hexadecimal format. Bit 0 in each register is the most significant bit.

Register Name:		Special Features Access Control Register
Offset from Base Address:		0x000
Field	**Bit**	**Description**
Feature ID High	0 ... 31	On all cameras, the value for Feature ID High field is: 0x0030 533B
Feature ID Low	32 ... 47	On all cameras, the value for Feature ID Low field is: 0x73C3
0xF	48 ... 51	This value for this field always 0xF.
Time Out	52 ... 63	On all cameras, the value for Time Out field is: 0x000

All advanced features registers, including the Access Control register, have been made part of Basler’s Smart Features Framework (SFF).

For more information about the SFF, see Section 9.2 on page 169.

12 Troubleshooting and Support

This section outlines the resources available to you if you need help working with your camera. It also provides some basic troubleshooting information that you can use to solve problems.

12.1 Tech Support Resources

The troubleshooting resources in this section of the manual will help you to find the cause of many common problems. If you need more assistance, you can contact the Basler technical support team for your area. Basler technical support contact information is located in the front pages of this manual.

If you do decide to contact Basler technical support, please take a look at the form that appears on the last two pages of this section before you call. Filling out this form will help make sure that you have all of the information the Basler technical support team needs to help you with your problem.

You will also find helpful information such as frequently asked questions, downloads, and technical notes at our website: www.baslerweb.com.

12.2 Troubleshooting with the Camera LED

If the camera boots up successfully, the LED on the back of the camera will light and will remain green continuously.

If an error condition is detected, the LED will begin to flash. The number of flashes indicates the detected error as shown in Table 22.

LED State	Status Indication
Off	No power to the camera
Continuous green	The camera is OK.
Continuous red	Internal error. Contact Basler technical support.

Table 22: LED Indications

12.3 Troubleshooting Charts

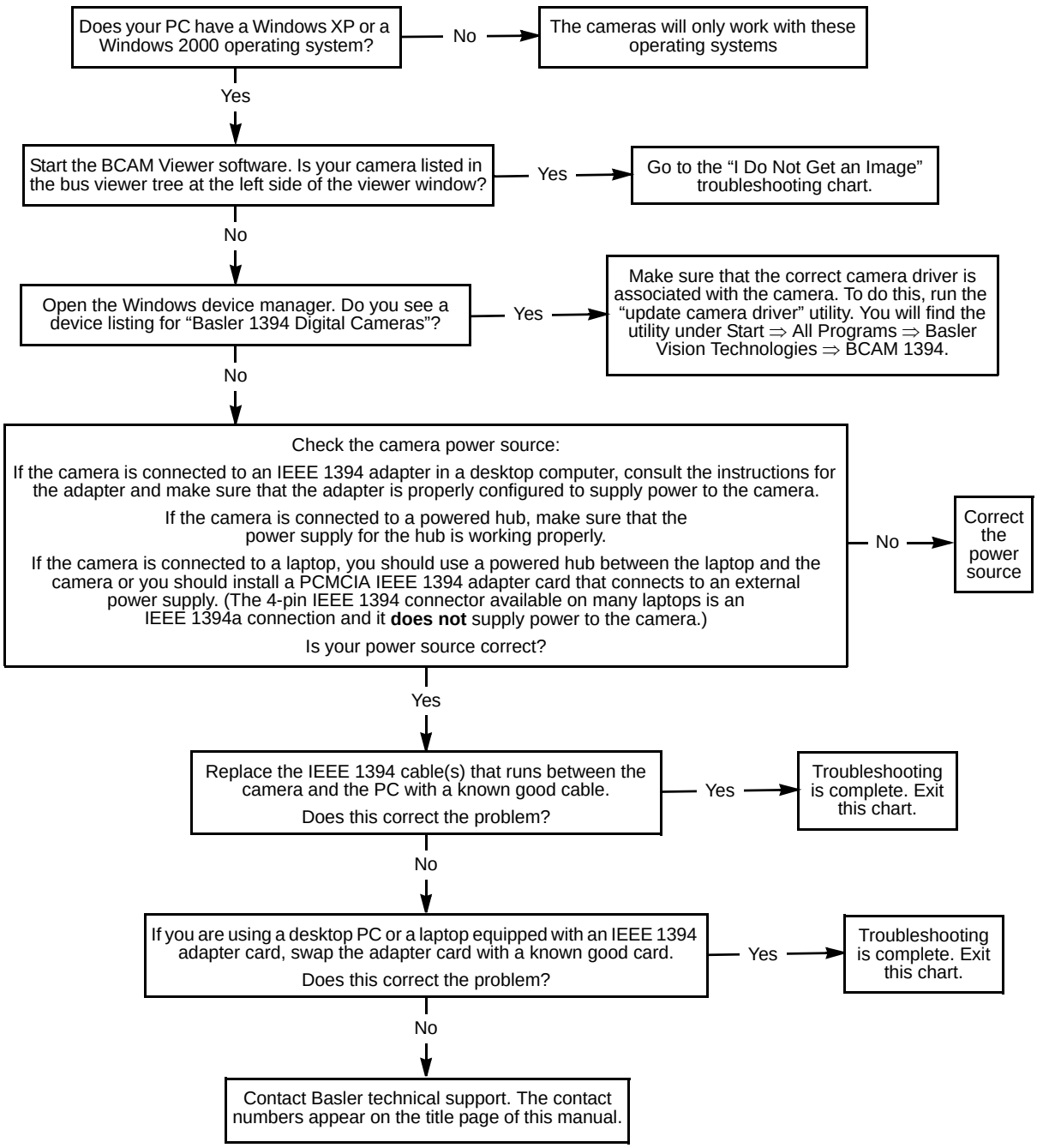
The following pages contain several troubleshooting charts that can help you find the cause of problems users sometimes encounter. The charts assume that you are familiar with the camera's features and settings. If you are not, we suggest that you review the camera manual before you troubleshoot a problem.

The charts also assume that you have the BCAM Viewer software installed on your host PC and that you are familiar with using the software.

For more information about the BCAM Viewer, see Section 5.2 on page 83 and Section 2.4 on page 53.

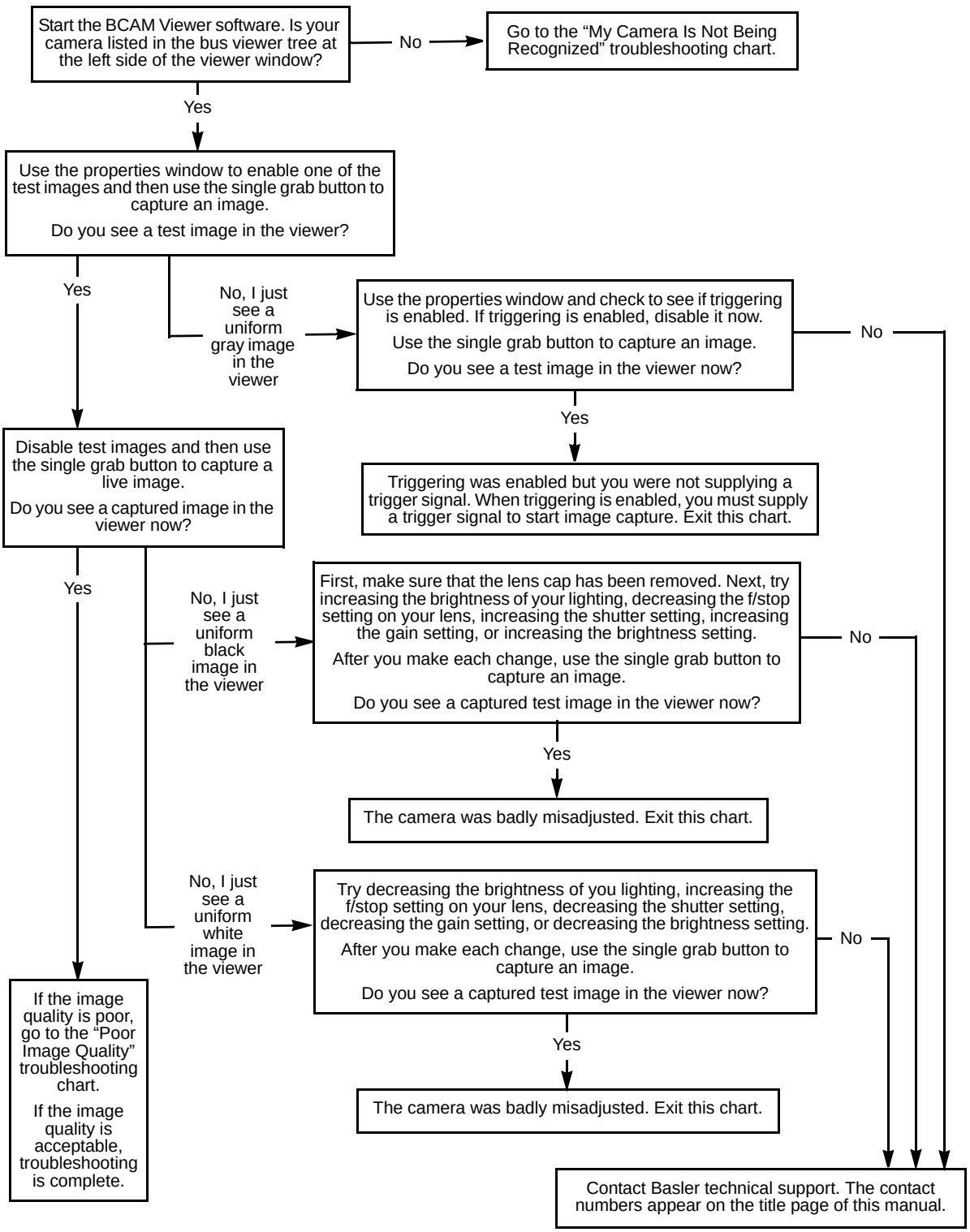
12.3.1 My Camera Is Not Being Recognized

Use this chart if your camera is connected to a PC, but is not being recognized by the PC.


Does your PC have a Windows XP or a Windows 2000 operating system?
No
The cameras will only work with these operating systems
Yes
Start the BCAM Viewer software. Is your camera listed in the bus viewer tree at the left side of the viewer window?
Yes
Go to the “I Do Not Get an Image” troubleshooting chart.
No
Open the Windows device manager. Do you see a device listing for “Basler 1394 Digital Cameras”?
Yes
Make sure that the correct camera driver is associated with the camera. To do this, run the “update camera driver” utility. You will find the utility under Start ⇒ All Programs ⇒ Basler Vision Technologies ⇒ BCAM 1394.
No
Check the camera power source:
If the camera is connected to an IEEE 1394 adapter in a desktop computer, consult the instructions for the adapter and make sure that the adapter is properly configured to supply power to the camera.
If the camera is connected to a powered hub, make sure that the power supply for the hub is working properly.
If the camera is connected to a laptop, you should use a powered hub between the laptop and the camera or you should install a PCMCIA IEEE 1394 adapter card that connects to an external power supply. (The 4-pin IEEE 1394 connector available on many laptops is an IEEE 1394a connection and it **does not** supply power to the camera.)
Is your power source correct?
No
Correct the power source
Yes
Replace the IEEE 1394 cable(s) that runs between the camera and the PC with a known good cable.
Does this correct the problem?
Yes
Troubleshooting is complete. Exit this chart.
No
If you are using a desktop PC or a laptop equipped with an IEEE 1394 adapter card, swap the adapter card with a known good card.
Does this correct the problem?
Yes
Troubleshooting is complete. Exit this chart.
No
Contact Basler technical support. The contact numbers appear on the title page of this manual.

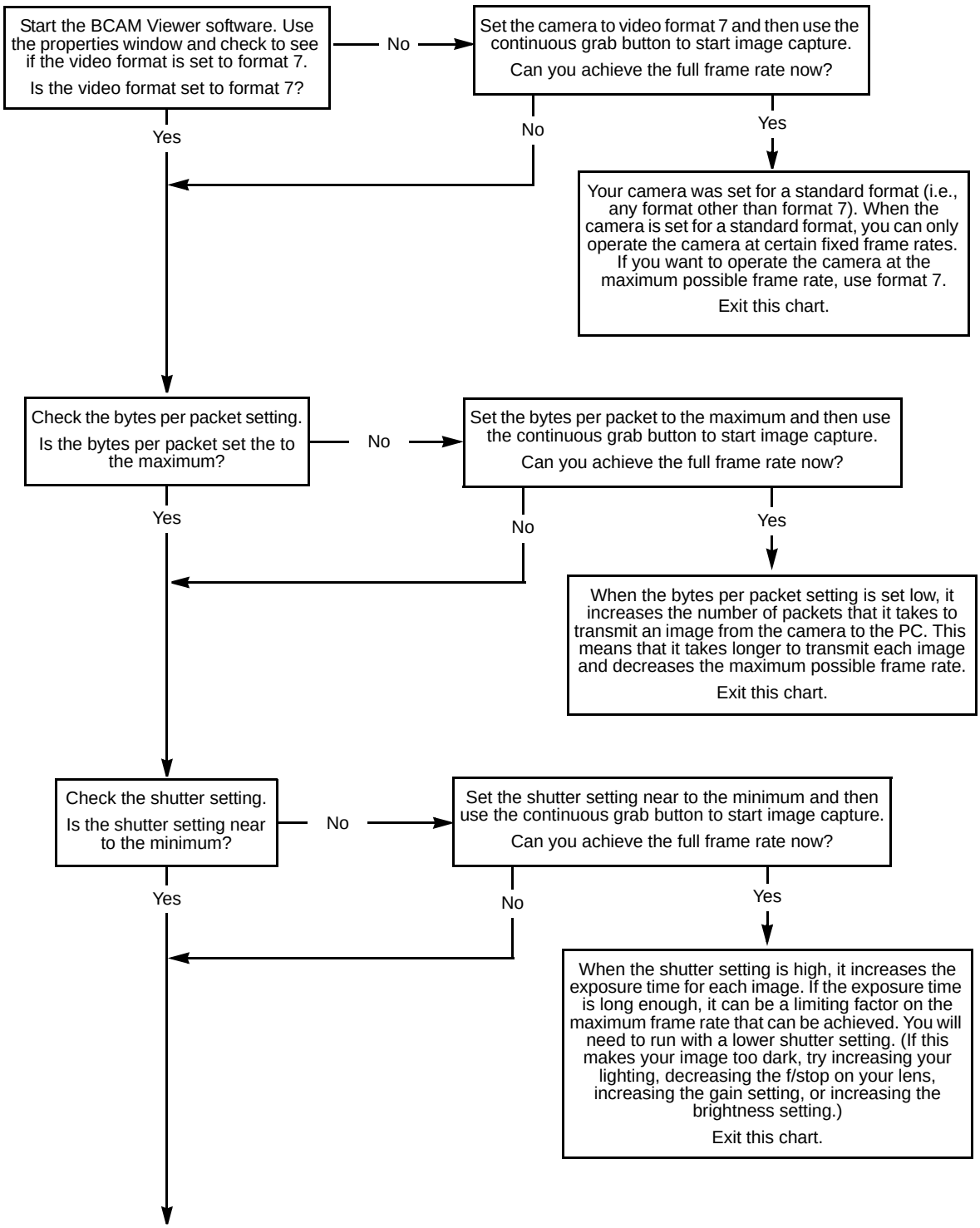
12.3.2 I Do Not Get an Image

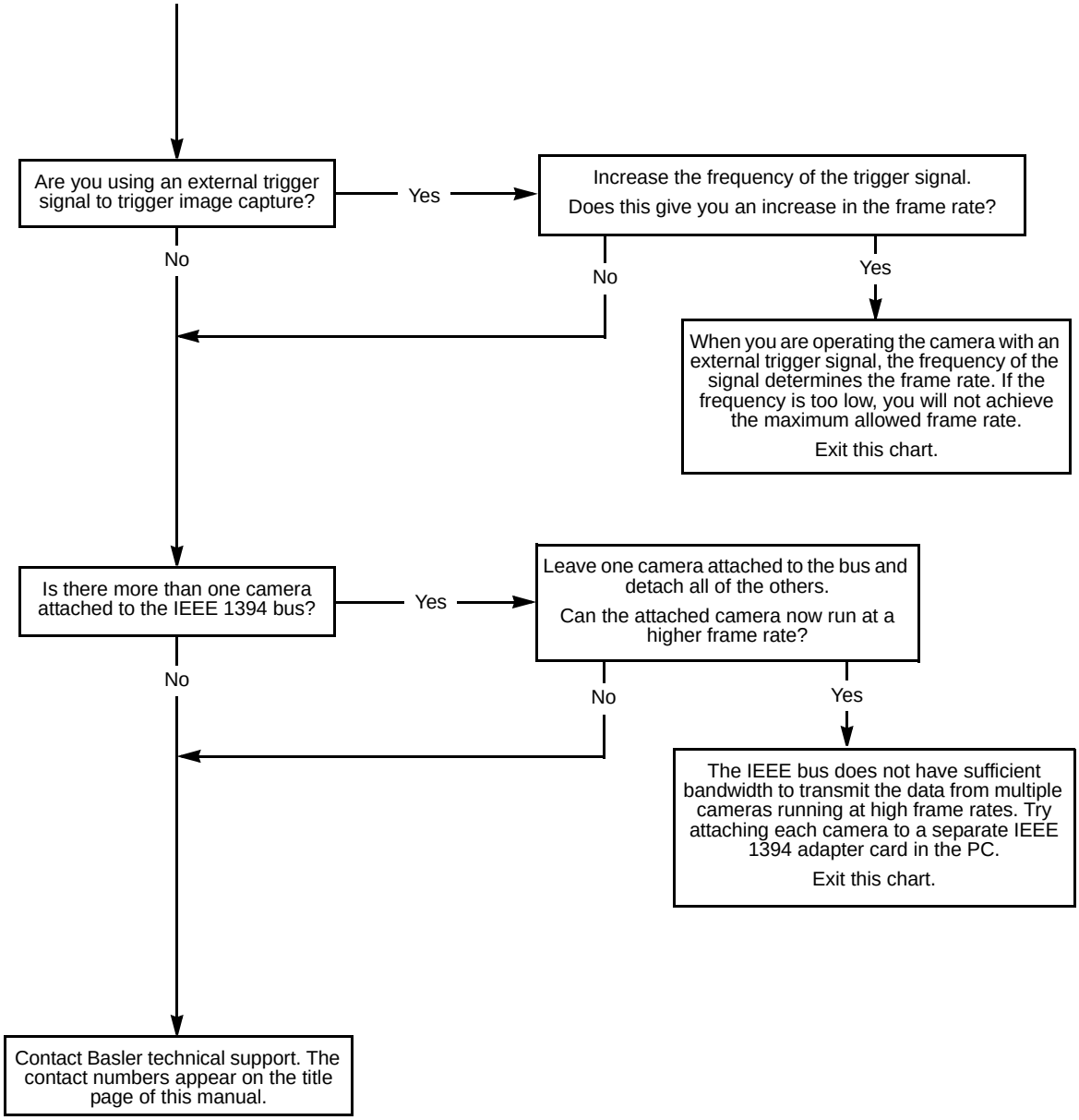
Use this chart if you get no image at all when you attempt to capture an image. If you get a poor quality image, use the "Poor Image Quality" chart.


Start the BCAM Viewer software. Is your camera listed in the bus viewer tree at the left side of the viewer window?
No
Go to the “My Camera Is Not Being Recognized” troubleshooting chart.
Yes
Use the properties window to enable one of the test images and then use the single grab button to capture an image.
Do you see a test image in the viewer?
Yes
No, I just see a uniform gray image in the viewer
Use the properties window and check to see if triggering is enabled. If triggering is enabled, disable it now.
Use the single grab button to capture an image.
Do you see a test image in the viewer now?
No
Yes
Triggering was enabled but you were not supplying a trigger signal. When triggering is enabled, you must supply a trigger signal to start image capture. Exit this chart.
Disable test images and then use the single grab button to capture a live image.
Do you see a captured image in the viewer now?
Yes
No, I just see a uniform black image in the viewer
First, make sure that the lens cap has been removed. Next, try increasing the brightness of your lighting, decreasing the f/stop setting on your lens, increasing the shutter setting, increasing the gain setting, or increasing the brightness setting.
After you make each change, use the single grab button to capture an image.
Do you see a captured test image in the viewer now?
No
Yes
The camera was badly misadjusted. Exit this chart.
No, I just see a uniform white image in the viewer
Try decreasing the brightness of you lighting, increasing the f/stop setting on your lens, decreasing the shutter setting, decreasing the gain setting, or decreasing the brightness setting.
After you make each change, use the single grab button to capture an image.
Do you see a captured test image in the viewer now?
No
Yes
The camera was badly misadjusted. Exit this chart.
If the image quality is poor, go to the “Poor Image Quality” troubleshooting chart.
If the image quality is acceptable, troubleshooting is complete.
Contact Basler technical support. The contact numbers appear on the title page of this manual.

12.3.3 I Can't Get the Full Frame Rate

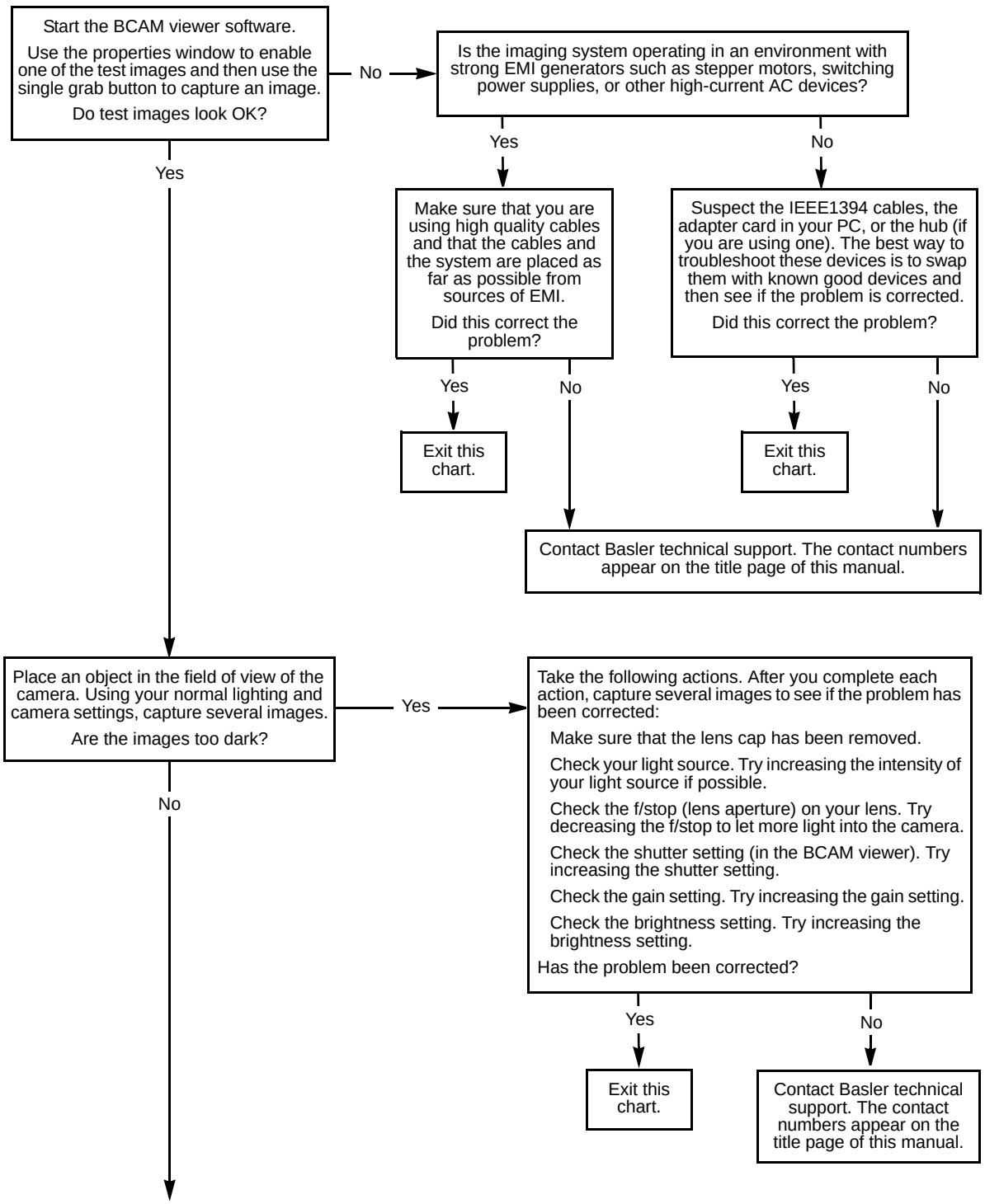
Use this troubleshooting chart if you are attempting to run the camera at its maximum stated frame rate and you are not able to do so.

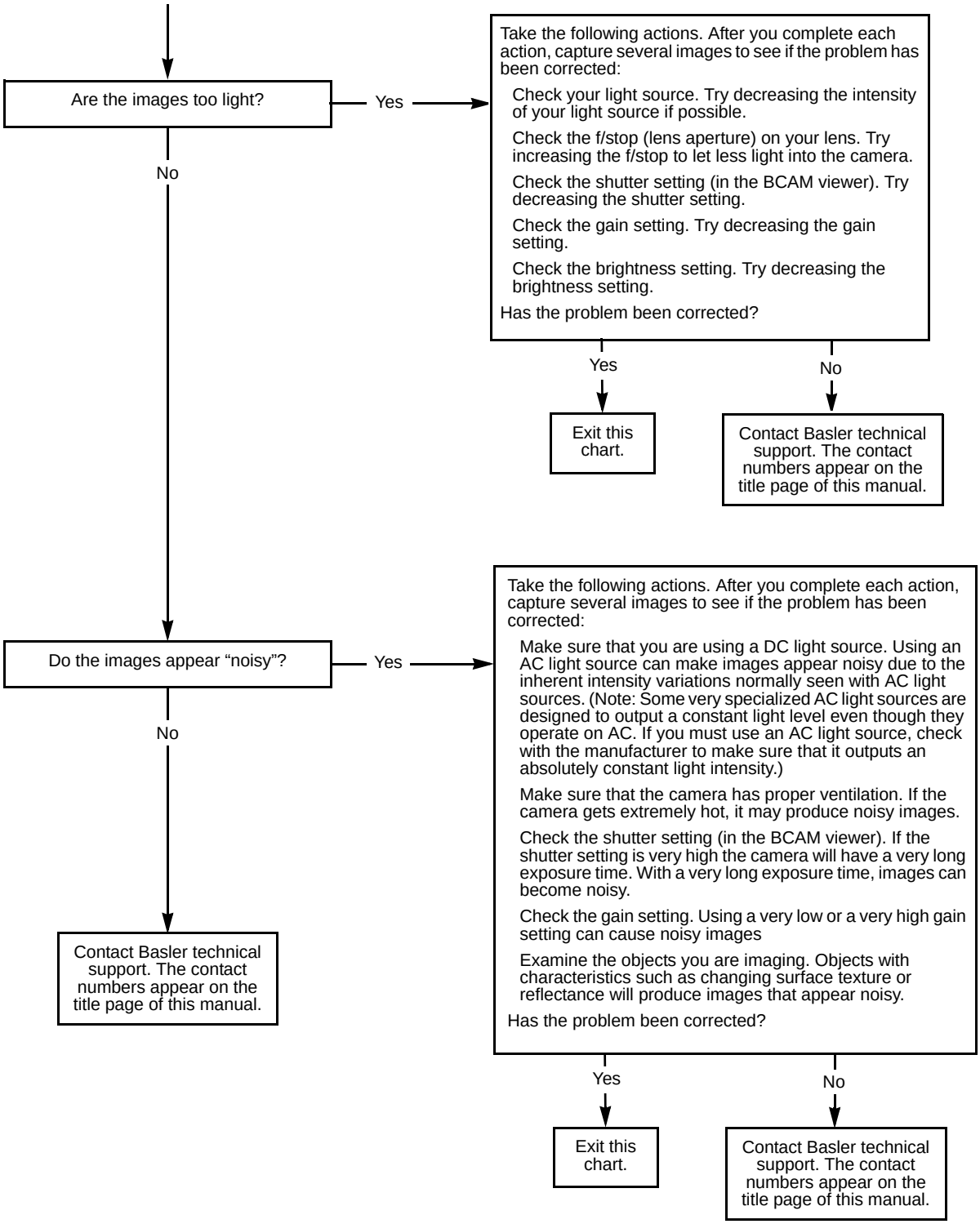

Start the BCAM Viewer software. Use the properties window and check to see if the video format is set to format 7.
Is the video format set to format 7?
No
Set the camera to video format 7 and then use the continuous grab button to start image capture.
Can you achieve the full frame rate now?
Yes
No
Yes
Your camera was set for a standard format (i.e., any format other than format 7). When the camera is set for a standard format, you can only operate the camera at certain fixed frame rates. If you want to operate the camera at the maximum possible frame rate, use format 7.
Exit this chart.
Check the bytes per packet setting.
Is the bytes per packet set the to the maximum?
No
Set the bytes per packet to the maximum and then use the continuous grab button to start image capture.
Can you achieve the full frame rate now?
Yes
No
Yes
When the bytes per packet setting is set low, it increases the number of packets that it takes to transmit an image from the camera to the PC. This means that it takes longer to transmit each image and decreases the maximum possible frame rate.
Exit this chart.
Check the shutter setting.
Is the shutter setting near to the minimum?
No
Set the shutter setting near to the minimum and then use the continuous grab button to start image capture.
Can you achieve the full frame rate now?
Yes
No
Yes
When the shutter setting is high, it increases the exposure time for each image. If the exposure time is long enough, it can be a limiting factor on the maximum frame rate that can be achieved. You will need to run with a lower shutter setting. (If this makes your image too dark, try increasing your lighting, decreasing the f/stop on your lens, increasing the gain setting, or increasing the brightness setting.)
Exit this chart.


Are you using an external trigger signal to trigger image capture?
Yes
Increase the frequency of the trigger signal.
Does this give you an increase in the frame rate?
No
No
Yes
When you are operating the camera with an external trigger signal, the frequency of the signal determines the frame rate. If the frequency is too low, you will not achieve the maximum allowed frame rate.
Exit this chart.
Is there more than one camera attached to the IEEE 1394 bus?
Yes
Leave one camera attached to the bus and detach all of the others.
Can the attached camera now run at a higher frame rate?
No
No
Yes
The IEEE bus does not have sufficient bandwidth to transmit the data from multiple cameras running at high frame rates. Try attaching each camera to a separate IEEE 1394 adapter card in the PC.
Exit this chart.
Contact Basler technical support. The contact numbers appear on the title page of this manual.

12.3.4 I Get Poor Image Quality

Use this chart if you can capture images, but they are poor quality. (If you can't capture images at all, use the "I Do Not Get an Image" troubleshooting chart.)


Start the BCAM viewer software.
Use the properties window to enable one of the test images and then use the single grab button to capture an image.
Do test images look OK?
No
Is the imaging system operating in an environment with strong EMI generators such as stepper motors, switching power supplies, or other high-current AC devices?
Yes
No
Yes
Make sure that you are using high quality cables and that the cables and the system are placed as far as possible from sources of EMI.
Did this correct the problem?
Suspect the IEEE1394 cables, the adapter card in your PC, or the hub (if you are using one). The best way to troubleshoot these devices is to swap them with known good devices and then see if the problem is corrected.
Did this correct the problem?
Yes
No
Yes
No
Exit this chart.
Exit this chart.
Contact Basler technical support. The contact numbers appear on the title page of this manual.
Place an object in the field of view of the camera. Using your normal lighting and camera settings, capture several images.
Are the images too dark?
Yes
No
Take the following actions. After you complete each action, capture several images to see if the problem has been corrected:
Make sure that the lens cap has been removed.
Check your light source. Try increasing the intensity of your light source if possible.
Check the f/stop (lens aperture) on your lens. Try decreasing the f/stop to let more light into the camera.
Check the shutter setting (in the BCAM viewer). Try increasing the shutter setting.
Check the gain setting. Try increasing the gain setting.
Check the brightness setting. Try increasing the brightness setting.
Has the problem been corrected?
Yes
No
Exit this chart.
Contact Basler technical support. The contact numbers appear on the title page of this manual.


Are the images too light?
Yes
Take the following actions. After you complete each action, capture several images to see if the problem has been corrected:
Check your light source. Try decreasing the intensity of your light source if possible.
Check the f/stop (lens aperture) on your lens. Try increasing the f/stop to let less light into the camera.
Check the shutter setting (in the BCAM viewer). Try decreasing the shutter setting.
Check the gain setting. Try decreasing the gain setting.
Check the brightness setting. Try decreasing the brightness setting.
Has the problem been corrected?
Yes
No
Exit this chart.
Contact Basler technical support. The contact numbers appear on the title page of this manual.
No
Do the images appear “noisy”?
Yes
Take the following actions. After you complete each action, capture several images to see if the problem has been corrected:
Make sure that you are using a DC light source. Using an AC light source can make images appear noisy due to the inherent intensity variations normally seen with AC light sources. (Note: Some very specialized AC light sources are designed to output a constant light level even though they operate on AC. If you must use an AC light source, check with the manufacturer to make sure that it outputs an absolutely constant light intensity.)
Make sure that the camera has proper ventilation. If the camera gets extremely hot, it may produce noisy images.
Check the shutter setting (in the BCAM viewer). If the shutter setting is very high the camera will have a very long exposure time. With a very long exposure time, images can become noisy.
Check the gain setting. Using a very low or a very high gain setting can cause noisy images
Examine the objects you are imaging. Objects with characteristics such as changing surface texture or reflectance will produce images that appear noisy.
Has the problem been corrected?
Yes
No
Exit this chart.
Contact Basler technical support. The contact numbers appear on the title page of this manual.
No
Contact Basler technical support. The contact numbers appear on the title page of this manual.

12.4 Before Contacting Basler Technical Support

To help you as quickly and efficiently as possible when you have a problem with a Basler camera, it is important that you collect several pieces of information before you contact Basler technical support.

Copy the form that appears on the next two pages, fill it out, and fax the pages to your local dealer or to your nearest Basler support center. Or, you can send an e-mail listing the requested pieces of information and with the requested files attached. Our Basler technical support contact information is shown in the title section of this manual.

1 The camera's product ID: _____

2 The camera's serial number: _____

3 1394 adapter that you use with the camera: _____

4 Describe the problem in as much detail as possible: _____
(If you need more space, use an extra sheet of paper.) _____

5 If known, what's the cause of the problem? _____

6 When did the problem occur?

☐ After start. ☐ While running.

☐ After a certain action (e.g., a change of parameters): _____

☐ _____

7 How often did/does the problem occur?

- ☐ Once.
- ☐ Every time.
- ☐ Regularly when: _____
- ☐ Occasionally when: _____

8 How severe is the problem?

- ☐ Camera can still be used.
- ☐ Camera can be used after I take this action: _____
- ☐ Camera can no longer be used.

9 Did your application ever run without problems?

- ☐ Yes
- ☐ No

10 Parameter set

It is very important for Basler technical support to get a copy of the exact camera parameters that you were using when the problem occurred.

To make a copy of the parameters, use the dump register tool available from the support section of www.baslerweb.com (the tool is available for XP PCs only). Send the generated file to Basler technical support. Or, you can look up the settings with the BCAM Viewer by using View > Camera Features and View > Properties.

If you cannot access the camera, please try to state the following parameter settings:

- ☐ Video format: _____
- ☐ Video mode: _____
- ☐ Color coding: _____
- ☐ Bytes per packet: _____
- ☐ Exposure time (shutter): _____
- ☐ Frame rate: _____

11 Live image/test image

If you are having an image problem, try to generate and save live images that show the problem. Also generate and save test images. Please save the images in BMP format, zip them, and send them to Basler technical support.

Revision History

Doc. ID Number	Date	Changes
AW00011501000	1 Aug2006	Initial release of this document.
AW00011502000	6 Nov 2006	Added information for the newly released scA1000-20fm/fc, scA1000-30fm/fc, scA1390-17fm/fc, and scA1600fm/fc cameras. Updated all affected text and tables as appropriate. Corrected tolerances in the dimension drawing in Section 1.5 on page 20. Added an I/O cable drawing to Section 4.4.2 on page 71. Added information about the BCAM Viewer to Section 5.2 on page 83. Added information about the minimum shutter time setting to Section 6.4 on page 98. Corrected the numbering in the illustration in Section on page 115. Corrected the color coding descriptions in Section 7.3.2.5 on page 137, Section 7.3.2.6 on page 140, and Section 7.3.2.7 on page 142. Corrected the color filter alignment description in Section 7.3.1 on page 128.
AW00011503000	27 Nov 2006	Corrected the SP2 rollback procedure in Section 2.3.2 on page 44.
AW00011504000	20 Mar 2007	Updated the camera weights in the specification table in Section 1.2 on page 2. Added the dimensions for cameras equipped with CS-mount lens adaptors to Section 1.5 on page 20. Updated the SP2 rollback procedure Section 2.3.2 on page 44. Added Section 8.8 on page 165 to describe the new configuration sets and memory channels feature. Added Section 9.5.6 on page 185 to describe the new CRC checksum smart feature. Added information for the newly released scA750-60gm/gc camera. Updated all affected text and tables as appropriate.
AW00011505000	11 Jun 2007	Added information on IP30, Section 1.5.1.1 on page 20 and Section 1.5.2.1 on page 25. Added information (drawings inclusive) on the 90° head housing variant: Section 1.6.2 on page 30. Added information on mechanical stress test results: Section 1.5.4 on page 29. Added information on the 8 bits effective pixel data: Section 7.3.2.1 on page 132, Section 7.3.2.2 on page 133, Section 7.3.2.5 on page 137, Section 7.3.2.8 on page 144 and Section 7.3.2.9 on page 147. Minor modifications througout the manual: modified frame height to AOI height.

Doc. ID Number	Date	Changes
AW00011506000	15 Oct 2007	Modified mechanical drawings in Section 1.5.1.1 on page 20 (dimensions), Section 1.5.2.1 on page 25 (dimensions), Section 1.5.2.2 on page 27 (front module reference planes), and deleted excess receptacle in Figure 20 in Section 1.5.1.1 on page 20. Added note on internal dust seal in Section 1.7 on page 31. Added warning not to remove the serial number in Section 1.7 on page 31. Updated times in Section 4.7.2.3 on page 81. Completed information on receptable pin assignments in Figure 40 in Section 4.7.2.3 on page 81. Removed note on scA750-60 output in Sections 7.3.2.1 on page 132, 7.3.2.2 on page 133, 7.3.2.5 on page 137, 7.3.2.8 on page 144, and 7.3.2.9 on page 147. Minor corrections throughout the manual.
AW00011507000	21 Dec 2007	Added guidelines for avoiding EMI and ESD problems in Section 1. on page 37. Corrected the voltage ranges relating to logic 0 and logic 1 in Section 4.7.1 on page 76. Added references to Application Notes AW000565xx000 in Section 6.3.1 on page 92 and Section 6.5.1 on page 101. Added minimum gain settings with vertical binning in Section 8.1 on page 151. Added the gamma feature in Section 8.5 on page 160, Section 11.1.8 on page 256, and Section 11.2.2 on page 266. Corrected the sequence of fields in the green level feature CSR description in Section 9.6.1 on page 188. Added the binning smart feature in Section 9.6.2 on page 190. Added the disable parameter limits smart feature in Section 9.6.4 on page 206. Added the debouncer smart feature in Section 9.6.5 on page 207. Minor corrections throughout the manual.
AW00011508000	5 Mar 2008	Integrated the scA1400-30fm/fc. Corrected the type of interface in the table in Section 1.5.2.2 on page 27. Added information on the lens to which the mechanical shock tests apply in Section 1.5.4 on page 29. Added information on the input line transition threshold in Table 7 on page 69. Added the maximum values for the shutter time in Section 6.4 on page 98 and Section 9.6.8 on page 219. Added settings for obtaining the maximum shutter time in Section 9.6.8 on page 219. Added remarks about non-implementation of Absolute Value CSRs in Section 11.2.3 on page 273. Minor modifications and corrections throughout the manual.

Doc. ID Number	Date	Changes
AW00011509000	18 Jul 2008	Integrated the scA1300-32fm/fc. Updated the distances and related tolerances between the front of the lens mount and the sensor's photosensitive area in Section 1.5 on page 20. Indicated the applicability of the mechanical stress test to cameras with standard housing and an extended duration of the broad-band vibration test in Section 1.5.4 on page 29. Removed voltage information from Table 7 in Section 4.2.2 on page 69. Added Section 4.4.3 on page 73 and notes in Section 4.4.2 on page 71 introducing the PLC cable. Included detailed voltage information in Section 4.5 on page 74, Section 4.7.1.1 on page 76, and Section 4.7.2.1 on page 78. Modified the absolute maximum rating to +30.0 VDC in Section 4.7.1.2 on page 77 and Section 4.7.2.2 on page 79. Updated times in Section 4.7.2.3 on page 81. Added a note relating to the debouncer in Section 6.9 on page 109. Updated the brightness feature description and the brightness value range for the scA1400-30fm/fc in Section 8.2 on page 156. Corrected the minimum values for the white balance settings in Section 8.3 on page 157. Extended the description of the debouncer in Section 9.6.5 on page 207. Minor modifications and corrections throughout the manual.
AW00011510000	22 Aug 2008	Updated contact addresses and phone numbers. Corrected the bit assignments for the Memory Save Channel CSR in Section 11.2.1 on page 261.

Feedback

Your feedback will help us improve our documentation. Please click the link below to access an online feedback form. Your input is greatly appreciated.

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